Fiber Broadband Feasibility Study

Created by ValleyNet and Rural Innovation Strategies, Inc., for the Vermont Department of Public Service, on behalf of the Addison County Regional Planning Commission and the Addison Communications Union District

December 4 2020

Broadband Innovation Grant Process

The Addison County Regional Planning Commission (ACRPC), in collaboration with the Addison Communications Union District, was awarded a Broadband Innovation Grant (BIG) in April 2020. ValleyNet and Rural Innovation Strategies, Inc (RISI) were hired to execute on the grant, and work began in August 2020.

The Broadband Innovation Grant process has two components. First, it includes funding for a feasibility study to determine whether it is financially and technically possible to provide fiber broadband service to every unserved premise in the region by forming a Communication Union District (CUD). Then, upon the feasibility study's review and approval by a third party and by the state of Vermont, the Broadband Innovation Grant supports the creation of a business plan and detailed financial modeling to allow the Communication Union District to adopt an operating and governance model that fits the needs of the region.

Executive Summary

To be considered viable for the purposes of this report, a fiber network must be technically feasible, must be able to reach a critical mass of customers to be sufficiently profitable to operate in the long run, and be able to grow to that critical size while remaining financially stable, and EBITDA positive (Earnings before Interest, Taxes, Depreciation, and Amortization positive) starting in year three.

This study first finds that the Addison region presents no major technical challenges to building a fiber network. This study also finds that building a network in the region could eventually comprise 5,000 customers, achieving a scale that would make it attractive to an operator.

However, the project's feasibility depends heavily on the ultimate make-up of the CUD, the cost of capital available to the CUD, and/or the partnerships available with existing operators.

The sources of capital known to be available to the CUD at this point are a 4M VEDA loan at 3%, subordinated debt at 8-9%, and revenue bonds at 5-6% that can be accessed around year 5. If the CUD were to encompass only Addison County towns, given the cost of construction and the number of customers the network can expect to serve, the Internal Rate of Return (IRR) of the network would be 4.6%, lower than the average cost of capital, which makes the project unviable in the long run.

This determination is the result of two factors, the first being the low density of the region. The average number of buildings per mile is 17.8 in the Addison County Region. In comparison, there are 21.2 buildings per mile in Windham County, 23.5 per mile in Rutland County, and 27.7 per mile in Bennington County. Lower density in Addison County means that a greater number of miles must be constructed to reach each customer.

Second, construction and materials costs have gone up appreciably even in the past few months, driven largely by increased demand for skilled broadband construction labor, the pandemic's reduction of factory capacity, and tariffs on Chinese goods. The combination of increased construction costs and low density means that the average cost to reach a customer is too high to build a financially sustainable network with a high cost of capital.

However, the project becomes feasible in a few scenarios. If the Addison CUD is able to secure additional low-interest or favorable loans, such as a Rural Utility Service (RUS) loan through the USDA, or an expanded VEDA loan, that may lower the total cost of capital to the point where it would be possible to build a financially feasible network only consisting of towns in the Addison County Region. This is less in the control of the Addison County CUD, however there is ongoing discussion of providing more resources to rural broadband and the state and federal level, and more favorable resources may soon be available to the CUD.

If the Addison CUD cannot secure a low-cost loan, the CUD also has a feasible path by forming an "operational partnership" or merging with a neighboring CUD — most likely the Otter Creek CUD. An operational partnership would entail coordinating with a neighboring CUD to pick the same network operator and designing and constructing the networks with the intent that they be operated by the same entity. Both an operational partnership or a merger would provide benefits by allowing for cost savings due to greater scale and greater overall density, and it would make the network a more attractive opportunity for a range of potential operators who could feel more confident they could reach a viable number of customers to be healthy and profitable. This report includes a model that shows that a merger or cooperation with Otter Creek makes the CUD viable.

Lastly, the Addison CUD could also create a feasible network by partnering with an existing provider in the same region — for example, Waitsfield Champlain Valley Telecom. Though the CUD would still build and own infrastructure, the effect would be that the CUD facilitates the expansion of an existing network. In this scenario, the CUD would not have to worry about reaching 5,000 customers because they would simply be adding to the existing customer base of an already successful, cash-flow positive network. This also allows the CUD to achieve economies of scale on equipment and services, saves on many operational costs, and overall relieves the pressure to build in an aggressive (and risky) way that would otherwise be necessary with a new network.

This study outlines the base case of Addison CUD operating alone, proves that a network comprised of the Addison County region with a neighboring CUD would be viable, and outlines at a high level the pros, cons, and actions needed to enact an operational partnership or merger with a neighboring CUD. This study also examines the competitive landscape in Addison county, project risks, and the possibility of partnering with a local incumbent telephone company, such as Waitsfield and Champlain Valley Telecom, for operations of the network.

Ultimately, this report recommends that a business plan in Phase II can be built around whichever option the CUD elects to pursue, incorporating details such as the particulars around what a partnership with an existing operator would require from each party, the results of the RDOF auction, and updated information on other potential sources of funding.

Background Information

The Addison County Region

The Addison County Region studied for this project includes 20 towns in Addison County covered by the Addison County Regional Commission.[1]

[1] Addison, Bridport, Bristol, Cornwall, Ferrisburgh, Leicester, Lincoln, Middlebury, Monkton, New Haven, Orwell, Panton, Ripton, Salisbury, Shoreham, Starksboro, Vergennes, Waltham,

Towns in the Addison County Region range in size from less than 500 to over 8,000 in population. The total number of housing units (including second homes) in the region is around 16,800 and the total full-time residents are around 36,200.

The economy is diverse and includes a mix of tourism and recreation, education, healthcare, professional services, manufacturing, retail, and more. Median household income varies by town from about $54,000 to $91,000; Median household income in Addison County is about $65,000.[2] There are a sizable number of second homes in the region, as well as a range of part-time student residences associated with Middlebury College.

The largest town in the county is Middlebury, home to Middlebury College. Middlebury has just completed a multi-year $72 million construction project which has affected traffic and retail through its business district for the last several years. Combined with the COVID-19 pandemic, this construction has constrained activity in the downtown. Moving forward, this gives Middlebury the opportunity to revitalize and start afresh.

The Addison County Region is on the western border of the state and is south of Burlington. The Addison County Region is bounded by the southern portion of Lake Champlain on the west and the Green Mountains on the east. US-7 runs north-south through Addison county,

Weybridge, and Whiting are included. Granville and Hancock are in Addison County, but not in the Addison County Region; these towns are located on the western side of Addison County. Granville and Hancock are currently served with FTTP by East Central Vermont Telecommunications District (ECFiber).

[2] Income statistics from 2018 American Community Survey.

connecting Middlebury to Rutland and Burlington. VT-17 rand VT-125 run east-west and connect the county to New York over the Lake Champlain Bridge.

The eastern portion of the Addison County Region is covered by challenging mountainous terrain with few major roads that cross east-west and north-south. Existing infrastructure often dead ends on rural roads and traverses cross country off the roadway, making it difficult to create a network with redundant distribution. The terrain would also make it difficult for a wireless network to provide universal service.

The Addison County CUD

As of November 12, 16 towns have joined the Addison County CUD;[3] Bristol, Cornwall, Ferrisburgh, Leichester, Lincoln, Middlebury, Monkton, New Haven, Orwell, Panton, Ripton, Salisbury, Shoreham, Starksboro, Waltham, and Weybridge. (Goshen is in the Addison County Region but has joined the Otter Creek CUD.)

The CUD has adopted the name Maple Broadband, and is actively developing accounting and management systems, creating a web and marketing presence in the area. The CUD has also stated that they are committed to providing a great internet product with excellent customer service, and programs to support and assist lower-income Vermonters in affording service.

Using fiber to achieve universal broadband

The FCC defines "Broadband" as having access to speeds of 25 Megabits per second (Mbps) download, and 3 Megabits per second (Mbps) upload (known as 25/3Mbps). According to this definition, areas considered served have 25/3Mbps or better, and areas considered unserved have less than 25/3Mbps. This standard was set by the FCC in 2015, but much higher speeds will be required in the near future. <u>The authors of this study feel strongly that any areas not served by coaxial cable or fiber infrastructure will again be underserved in the very near term (or are already underserved).</u>

This belief is widely supported throughout the state. In 30 V.S.A. § 202c the Vermont Legislature voted to "support measures designed to ensure that by the end of the year 2024 every E-911 business and residential location in Vermont has infrastructure capable of delivering Internet access with service that has a minimum download speed of 100 Mbps and is symmetrical." This desire by the state can only be met by wired infrastructure (coaxial cable or fiber), and only fiber allows for continually greater speeds as demand increases.

Fiber broadband uses glass strands and lasers to carry light, which is used to transmit data at the speed of light, and this infrastructure solves the broadband access problem more completely than any other existing technologies today. Though setting up a network is cost

[3] https://publicservice.vermont.gov/sites/dps/files/documents/CUDsNov12.pdf

intensive, ongoing upkeep is relatively inexpensive, and the infrastructure will not degrade nor will the technology become outdated for decades.

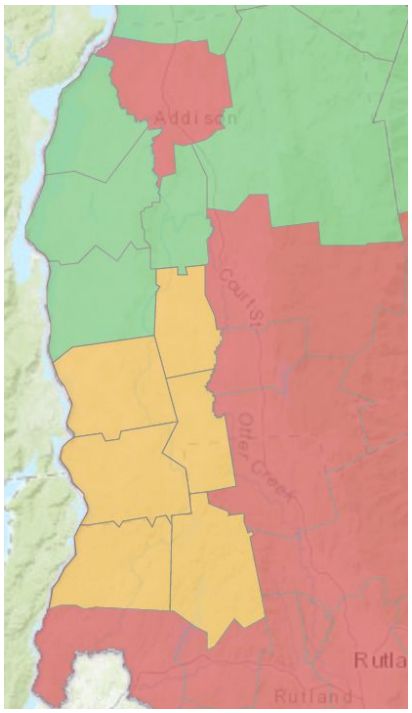
Current standard technologies allow 1Gbps symmetrical connections, however, this capacity can be scaled up even further as demand dictates. With commercially available technology today, it is possible to replace electronics at each central distribution site (hub site, roughly one per town) and in the home of each customer for a cost of $500-700 per customer to allow 10Gbps symmetrical connections. 100G technology is being tested, and 1 Terabyte speeds will be possible when demand exists.

Existing Broadband

There are many towns served by coaxial cable in the region that provide broadband (25/3Mbps) speeds or better; these services often do NOT cover the most rural parts of these towns. Comcast is the primary cable internet provider in the Addison County Region.

There are three incumbent telephone providers (also known as Incumbent Local Exchange Carriers, or ILECs) in the region that all offer DSL: Consolidated Communications, Waitsfield and Champlain Valley Telecom, and OTELCO. A map of the incumbent telephone provider's territories, which generally align with their DSL offerings, is shown below.

Incumbent Local Exchange Carriers



Red is Consolidated communications, Yellow is OTELCO, and Green is Waitsfield Telecom.

Waitsfield and Champlain Valley Telecom (WCVT) is a local, family-owned telephone provider. Green Mountain Access, a subsidiary of WCVT, provides telephone services DSL to the northern

and western portions of Addison County; additionally, Green Mountain Access provides fiber in some select locations within their footprint. WCVT has indicated that it has plans to expand fiber to their entire ILEC territory in the next five years, focusing on more densely populated areas first. WCVT has expressed interest in partnering with the Addison CUD to accelerate deployment; more detail on this potential partnership is included in the Network Operator section.

WCVT recently received $962,236 from through Vermont's Emergency Connectivity Initiative and Get Vermonters Connected Now Programs to extend fiber to 242 more locations, some of which are located in Bridport. The state of Vermont has awarded $12 million towards broadband expansions through these programs using CARES Act funding; the state recently awarded the third and final round of funding for these programs.

Waitsfield Cable, another subsidiary of WCVT, provides cable TV to towns north and west of Addison: Bolton, Fayston, Moretown, Waitsfield, and Warren.

OTELCO is a telephone provider in 6 states; it acquired Shoreham Telephone Company in 2011.[4] In addition to DSL internet, OTELCO also offers fiber to some select locations in its Addison County territory, and it has indicated that it may build more fiber in the region.[5]

Finally, Consolidated Communications is a publicly traded telephone provider in 23 states. It does not offer fiber internet to households in Addison County. That being said, Consolidated Communications is partnering with five New Hampshire towns to build a FTTH network[6] and recently announced that it will build fiber to 1.4 million homes across the country.[7]

Ultimately, fiber options in the Addison County region are currently limited. The impacts of potential fiber expansion by competitive providers are discussed in the Project Risks section.

Below is a map of existing cable (blue) and fiber (green) coverage in the Addison County region. (An interactive version of this map can be found at the Vermont Department of Public Service.[8])

Map of existing cable and fiber in the Addison County region

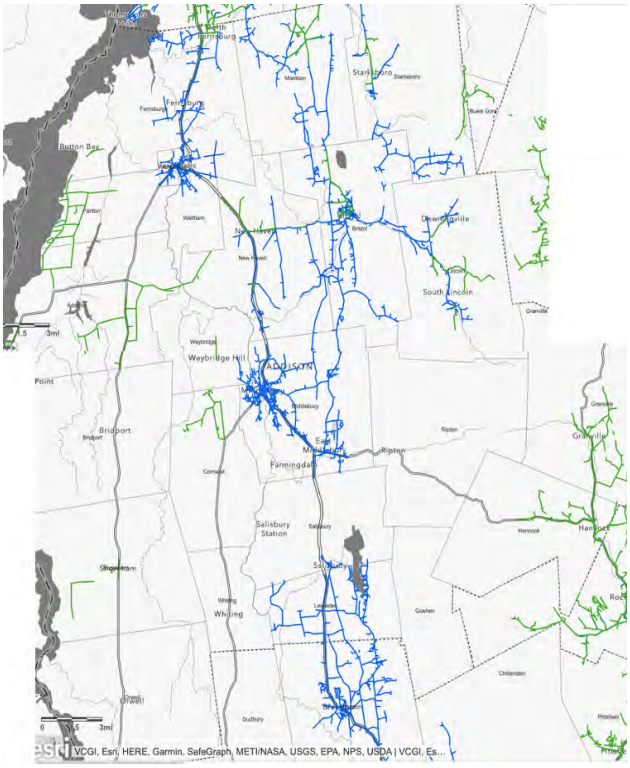
[4]https://www.businesswire.com/news/home/20111014005833/en/Otelco-Completes-Acquisition-of-Shoreham-Telephone

[5] https://lightwave.otelco.com/landing

[6]https://www.consolidated.com/about-us/news/article-detail/id/754/consolidated-communications-investing-4-million-to-expand-high-speed-broadband-in-five-new-hampshire-towns

[7]https://www.globenewswire.com/news-release/2020/09/14/2092812/0/en/Consolidated-Communications-Announces-Strategic-Investment-from-Searchlight-Capital-Partners-Initiates-Refinancing.html

[8] https://publicservice.vermont.gov/content/interactive-broadband-map



Beyond cable and fiber internet, DSL, Satellite, and mobile data are currently the primary means of accessing the internet for the rest of the region. North Branch Networks also provides fixed wireless internet to about 60 customers in Ripton, Vermont. None of these options provide reliable or sufficient broadband speeds. All are affected to some extent by the weather and struggle especially with providing upload speeds capable of video-conferencing and other upload-intensive activities.

North Branch Networks

North Branch Networks (NBN) is a fixed wireless network that currently serves 60 customers in Ripton, Vermont, including 3 customers who are “off the grid”. The Ripton Town Clerk’s Office is also a customer of NBN.

NBN was founded to “meet the demand of rural Vermont residents and businesses for affordable access.” As such, NBN’s values align closely with Addison CUD’s mission. Recognizing that fixed wireless can no longer meet many customers needs and that NBN’s customers would be better served by fiber, the owner of NBN, Jeremy Grip, has offered to partner with Addison CUD to transition NBN customers to the CUD’s fiber offering (and will eventually cease offering a fixed wireless service). Jeremy has also offered additional resources to Addison CUD, including contact information for former customers and a detailed map of vertical assets in the region.

This generous offer will allow the CUD to increase subscription rates in the Ripton area, and in phase two of the BIG Grant, the project team will incorporate a transition plan for NBN's customers into the business plan.

Additionally, NBN is working with the CUD and the project team to determine whether Vermont Connectivity funding could be used to expand fixed wireless services to help solve resident's short-term connectivity needs during the COVID-19 crisis. While fixed wireless internet will not be sufficient for many consumers in the long run, and fiber is the only technology considered "future proof," fixed wireless may be able to fill connectivity gaps in the short run.

Additional broadband technology being developed, deployed, or expanded

In addition to the longtime service models listed above, there are a few broadband technologies that are either currently being developed and therefore may be relevant to the region in the near future (5G and Low Earth Orbit satellites) or are currently being expanded in the region (VTel 4G LTE Wireless). <u>These technologies are important to understand and be aware of; however, they do not provide a viable alternative route to providing universal coverage for the region.</u>

5G is the 5th generation mobile network. 5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a uniform user experience to more users. That being said, 5G providers promote the fastest potential speeds, not the internet speeds achieved in real life. For example, 5G signals are hindered by common physical barriers like hills and trees.[9] Overall, actual speeds experienced by wireless users are often only 15 percent of the peak data connection rate, even though the peak data connection rate is the speed advertised.[10] Additionally, wireless internet solutions are generally less stable than wired internet, like FTTP.

Perhaps more importantly, this technological advancement comes from utilization of short range airwaves, which exist within 800 feet from 5G enabled antennas. Each antenna is usually connected/backhauled to the Internet with fiber. To reap the full benefits in rural areas, all premises would need to be within 800 feet of an antenna. This would require a significant fiber network to connect each tower, as well as investments in new towers and base stations. As cell carriers decide where to begin deploying 5G networks, they will likely focus on high density cities first, and may never bring 5G to rural areas.

Low Earth Orbit (LEO) satellite internet is another emerging technology that has received significant attention. In particular, Elon Musk's company SpaceX is in the process of building Starlink, which aims to use LEO satellites to provide internet; Starlink recently deployed 58 more satellites and is preparing for beta testing. LEO satellite companies aim to create a

[9] pcmag.com/news/testing-verizon-5g-in-chicago-speedy-but-watch-out-for-that-tree
[10] https://www.bbcmag.com/rural-broadband/5g-is-not-the-answer-for-rural-broadband

constellation of satellites to provide better internet coverage than traditional GEO satellites. In particular, because these satellites are closer to earth, they will provide connections with lower latency than traditional satellite internet.

The ultimate extent and quality of Starlink's service is not known at this time. While the impact could be significant if Starlink is able to provide quality internet for a reasonable price, LEO satellite internet must clear several hurdles in order to reach this point:

- Traditional satellite internet providers have data caps. It is unclear what the pricing tiers and data caps will be with LEO satellite services, but capped service may not meet many consumers' needs.
- While fiber internet will remain relevant for decades to come, and will be able to handle faster speeds as bandwidth needs increase, the same cannot be said for LEO satellite internet. LEO internet speeds will decrease when more users attempt to get online. While recent beta testing demonstrated decent speeds — 30-60 Mbps download and 5-18 Mbps upload[11] — only a small number of users were connecting during beta tests. Because all internet traffic must be routed through a finite number of satellites, speeds will almost certainly go down as the service is used by more people.
- LEO satellites, and StarLink in particular, have made progress towards clearing one major hurdle: latency (lag time). Initially, it was not known if LEO satellite internet would be able to meet the latency needs of consumers who use technologies such as video conferencing. Starlink then claimed they reached latency of 50 ms or less, and showed latency of 31-94 ms in recent beta tests.[12] While the FCC initially communicated "serious doubts" that LEO satellite technology can provide adequate connectivity at scale to compete as a "low-latency provider" (100 ms or less) in the Rural Digital Opportunity Fund (RDOF) auction,[13] the FCC recently approved StarLink as a qualified bidder in the low-latency category.[14] StarLink still needs to prove they can deliver low-latency service at-scale though.

[11]https://arstechnica.com/information-technology/2020/08/spacex-starlink-beta-tests-show-speeds-up-to-60mbps-latency-as-low-as-31ms/
[12]https://arstechnica.com/information-technology/2020/08/spacex-starlink-beta-tests-show-speeds-up-to-60mbps-latency-as-low-as-31ms/
[13] https://www.cnet.com/news/fcc-has-serious-doubts-about-spacexs-broadband-service/
[14]https://arstechnica.com/tech-policy/2020/10/spacex-gets-fcc-approval-to-bid-in-16-billion-rural-broadband-auction/

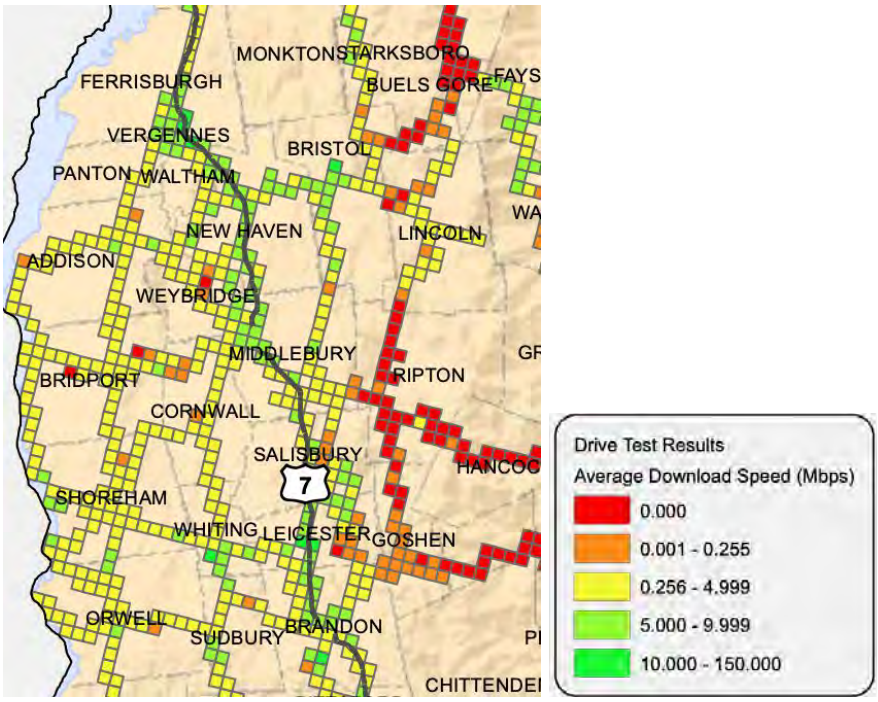
LEO satellites are important to continue to monitor, but at this point the project team has not seen proof that LEO satellites can provide cost effective and robust internet coverage to compete with fiber, especially with long-term resiliency in mind. .

VTel Wireless is a 4G LTE (Fourth Generation - Long Term Evolution) technology. The network consists of wireless sites throughout Vermont on towers, silos, steeples and other high spots. 4th generation of mobile communications allows for large amounts of data to be sent and received. However, as with most wireless technologies, it is not universal, and not every served location has access to the same speed or capacity. It is very dependent upon where the access site is located in relation to a customer, as well as the number of customers served by the same base station; customers may see slower speeds during peak hours. 4G LTE generally delivers speeds in the range of 5-12 Mbps download and 2-5 Mbps upload. Occasionally under ideal conditions it may deliver speeds approaching 50 Mbps download, though this is nothing remotely close to the capacity and consistency that fiber can provide. Although the VTel 4G LTE network has delivered internet access to many in rural Vermont, it is not ubiquitous and many continue to be unserved, despite VTel's stated intention to expand their network.

Utilities and additional telecommunications access

The landscape of non-internet utilities and telecommunications access in the Addison County Region is typical for mountainous and forested terrain. Data collected by the Department of Public Service in 2018 show serious gaps in cellular coverage in the eastern, mountainous towns, such as Starksboro, and Ripton. While cell coverage is more consistent in the western portion of the region, average download speeds are less than 5 Mbps, which is not sufficient for many common internet applications. This lack of service is due to a lack of cell towers or small-cell receivers sufficient to serve the entire area, which in turn could be due to lack of fiber backhaul to support cell transmission. The CUD's ability to offer cellular tower backhaul or to support small-cell receivers will be discussed in the business planning phase.

PSD 2018 Mobile Wireless Drive Test[15]



Green Mountain Power provides electricity to the entirety of the Addison County Region.

Economic Development

It may go without saying that high speed broadband is a critical foundation to a thriving, diverse economy. Robust broadband infrastructure has been shown to increase job productivity in rural areas[16], but not only do downtown and commercial areas need to be connected to conduct business, *residential* Internet service is crucial for home businesses and those who work from home. Furthermore, even before the COVID pandemic and physical distancing guidelines, the American Community Survey estimated that 9.7% of workers in Addison County worked from home — i.e., they worked remotely, or they ran a business out of their home.[17]

Connecting vacation and second homes throughout the area will encourage vacationers to stay longer because they can work remotely, thereby bringing more business to local economies. The CUD and/or operator may choose to offer contracts that allow second-homeowners to shut off service for half a year, further encouraging seasonal Vermonters to subscribe to fiber

[15] An interactive version of this map is available at https://publicservice.vermont.gov/content/mobile-wireless-drive-test
[16] https://dailyyonder.com/research-report-broadband-and-job-productivity-what-matters/2020/08/05/
[17] https://data.census.gov/cedsci/table?g=0500000US50001&tid=ACSST5Y2018.S0801&hidePreview=false

broadband. Further, access to fiber broadband raises property values by 3-5%,[18] and apartment buildings with fiber fill vacancies faster than ones without it.[19] Lack of sufficient broadband impacts the ability of homeowners to sell their homes at any price.

Further, the education system relies on broadband to connect students with teachers, to provide adult online education resources, and to simply give Vermonters better access to education. Broadband is also critical to healthcare, connecting patients with medical providers for appointments and information, monitoring chronic diseases, and for remote therapy sessions. In workplace, healthcare, and education contexts alike, the ability to video conference with high definition, consistent streaming quality, and low latency allows participants to read facial expressions and empathize, creating a communication environment that leads to better outcomes for all.

Importantly, fiber broadband is also future-proof, meaning it will remain relevant, competitive, and scalable as the technology enmeshed in our lives continues to advance and evolve. A fiber network will serve the region's bandwidth needs today and for decades to come.

Determining Need

The most important aspect of determining a region's need for broadband is understanding where there is and isn't existing 25/3Mbps broadband or, for all intents and purposes, where there is existing coaxial cable or fiber and where there is not.

In understanding where broadband is available in the region, this study utilized Vermont Public Service Department (PSD) 2019 data on the current location of cable and fiber. The following chart outlines a town by town summary of served and unserved areas according to the Public Service Department.

Knowing where cable and fiber exist is important for two reasons. First, existing cable and fiber will be the strongest competition to a new fiber network, and as such, any areas with existing cable that get "overbuilt" by the CUD will see lower subscription rates (overbuilding fiber is not recommended). Second, it is more expensive to build in areas with existing cable or fiber, as there are more wires on the utility poles. Areas with cable or fiber will be referred to as "cabled."

	Population	**PSD Premises**	**% Served with fiber or cable**
Addison	1424	853	45.13%

[18] https://www.fiberbroadband.org/blog/study-shows-home-values-up-3.1-with-access-to-fiber
[19] Knutson, Ryan, "How Fast Internet Affects Home Prices," *Wall Street Journal,* June 30, 2015, https://www.wsj.com/articles/SB11064341213388534269604581077972897822358

Bridport	1316	662	16.47%
Bristol	3914	1600	94.25%
Cornwall	996	582	18.90%
Ferrisburgh	2736	1667	56.21%
Leicester	1197	699	96.28%
Lincoln	1374	682	64.81%
Middlebury	8600	2926	95.76%
Monkton	1949	905	74.70%
New Haven	1687	820	65.12%
Orwell	1321	748	0.00%
Panton	654	330	53.64%
Ripton	549	377	9.55%
Salisbury	1087	877	15.28%
Shoreham	1073	741	13.50%
Starksboro	1979	916	69.54%
Vergennes	2612	1017	100.00%
Waltham	452	225	52.44%
Weybridge	866	409	43.52%
Whiting	344	185	0.00%
Total	**36264**	**17362**	**61.76%**

Most towns are partially covered by cable or fiber. Two towns have no coverage —Orwell and Whiting. In contrast, the towns with almost universal coverage include Bristol, Leichester, Middlebury, and Vergennes.

This data, along with population and housing units per mile data, allows us to determine which towns have the most unserved areas, and which have the most densely located households and businesses without service.

Decision not to conduct a take-rate survey to inform feasibility report

Feasibility studies sometimes include a survey of residents in order to determine existing broadband coverage and demand for better connectivity.

In this case, the project team decided to forgo a residential survey for several reasons. First and foremost, the project team is able to utilize historical data from ECFiber, the network in East Central Vermont that ValleyNet operates. More information on ECFiber can be found below in the section on Communication Union Districts. Historical ECFiber data provides better information than surveys, which by their nature have to ask hypothetical questions. For example, surveys often ask residents whether they would switch to "competitively priced fiber." This question is difficult to answer in the abstract, without knowing how inconvenient it may or may not be to switch and without knowledge of actual pricing and service options (which will not be decided upon until an operator partner is chosen).

Second, the Department of Public Service provides highly accurate information on what locations are already served and unserved. This information — along with data on road miles per town and basic ACS data on populations and households — provides the primary inputs needed to conduct a feasibility study.

Finally, time is of the essence when building broadband, and conducting a robust survey would take at least 6 weeks. Ultimately, we concluded that we could accurately determine the feasibility of a fiber project in the Addison County Region without conducting a survey.

That being said, the project team may assist the ACRPC and the Addison County CUD with a broadband survey to help them apply for and allocate CARES act dollars meant to connect remote workers and students. Should results from that survey inform the business plan in a meaningful way, they will be incorporated at that stage.

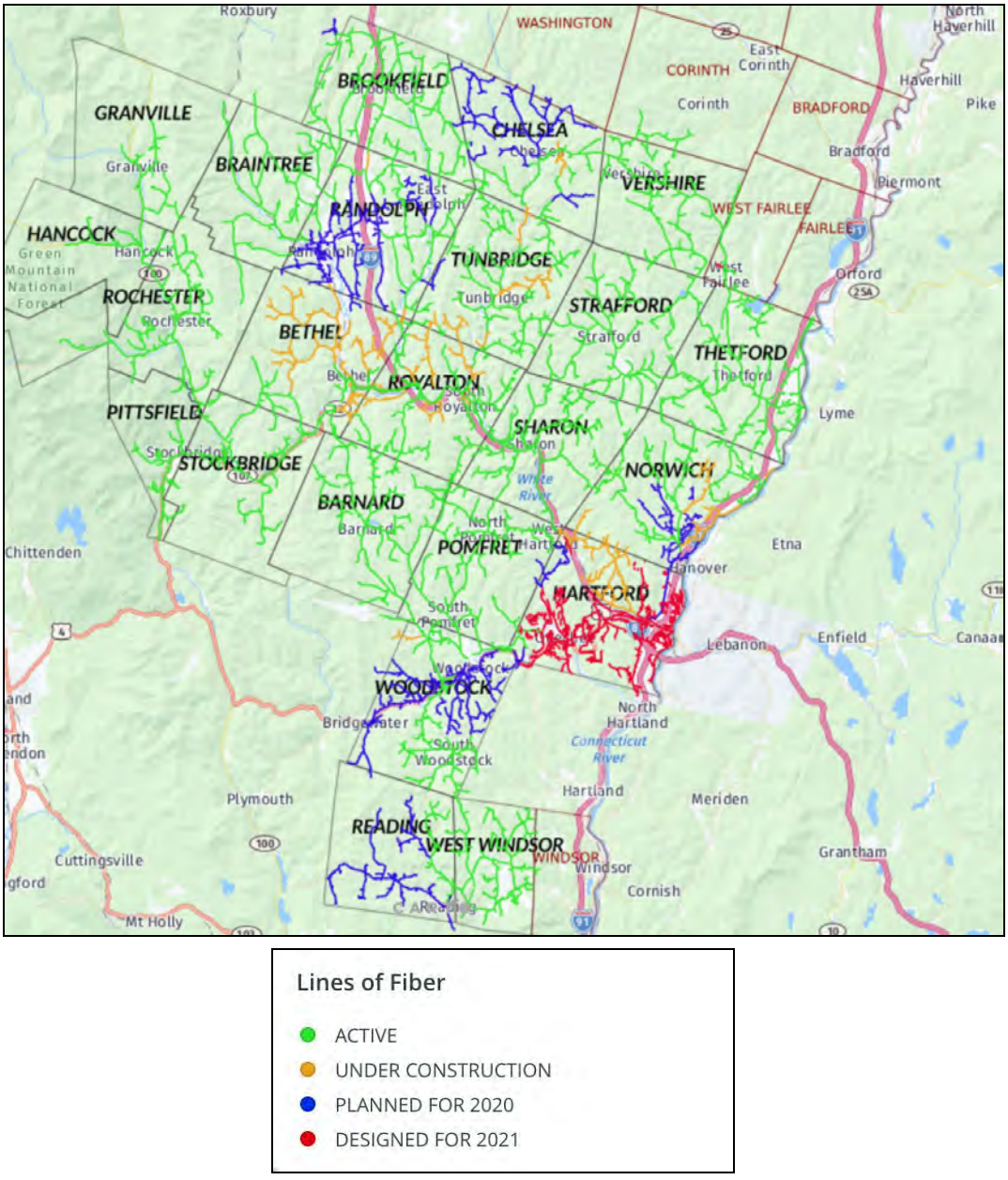
Communication Union Districts

In 2015, the Vermont Legislature authorized the formation of Communication Union Districts,[20] enabling multiple towns to join together to provide communication infrastructure to residents. Much like a water and sewer or solid waste district, this allowed towns to aggregate demand for a service and find efficiency by sharing operation of the district. Critically, in Vermont, this legislation also ensures that taxpayers in individual towns are not liable or responsible for mismanagement or failure of the CUD to repay debt incurred in building the network.

The East Central Vermont Telecommunications District (ECFiber) has been operational as a CUD since 2016, and serves as a model for this project. Prior to the 2015 legislation, ECFiber towns were organized through an Interlocal Contract; after the establishment of the ECFiber District, all towns became a part of the first CUD in Vermont. The initial CUD included 23 towns, and has since expanded to 31 towns. ECFiber focuses on serving areas that previously did not have access to cable or fiber, though has done some overbuilding of areas served by coaxial cable both to reach other unserved areas, and in denser downtown areas (e.g., Randolph) to compete for customers.

[20] 30 V.S.A § 3051

ECFiber's Network



Because the region covered by the ECFiber CUD generally resembles the Addison Region in terms of population, socioeconomics, existing infrastructure assets, and geography, data from the ECFiber district is used to guide this feasibility study.

Determining the optimal size of the Addison CUD

The newly formed Addison CUD is looking to the guidance of this feasibility study to understand whether their current make-up is sufficient to allow for a feasible network, or if they would be better served expanding or merging with another CUD.

The minimum number of towns in a CUD by law is 2, however from a feasibility standpoint, enough customer demand needs to be aggregated in a CUD to make the business case for a fiber deployment viable, financeable, and large enough to create scale economies and attract an operator. In the project team's experience, CUDs should target 5,000 subscribers to achieve a viable size, if the intention is that the network is run by a private operator. Networks much smaller than this will not be big enough to generate comfortable margins once built and would therefore be unattractive to operators or financiers in the long term.

The size of a network needed to serve 5,000 customers is determined by how many *potential* customers are passed in unserved areas (without fiber or cable) and how many customers are passed in already served areas (areas with existing coaxial cable). In the case of the Addison CUD, this 5,000 customer threshold can be reached by building the network to all unserved areas and overbuilding some higher density areas with coaxial cable. Although it may be possible to reach 5,000 customers in Addison County alone, due to low density, in addition to recent construction cost inflation, it is not financially viable to build and operate a network in Addison alone at this point unless the CUD can secure additional low-interest financing.

Alternatively, the CUD could partner with a local provider with an existing customer base, like a local Incumbent Local Exchange Carrier (ILEC), to expand their fiber service region to cover the whole Addison CUD. This would lower the number of customers the CUD would need to aggregate to be viable for the operator. An agreement could be arranged between the CUD and an ILEC that provides new revenue for the ILEC and also makes the CUD more viable at its current size. The best candidate for an arrangement like this in Addison County would be Waitsfield & Champlain Valley Telecom.

Should the CUD not partner with an incumbent telephone carrier or similar existing operator, our team's recommendation, born out by the numbers presented in the models below, is to continue adding towns in the Addison region, and to either merge with another CUD or coordinate to choose an operator that is shared with a neighboring district. This can be referred to as an "operational partnership." Importantly, while the "operational partnership" model presented below includes all towns in the Addison region, the team found that a network made up of towns from the Rutland and Addison region that *excludes* towns in WCTV's territory is also viable.

In order to ensure timely customer service, the driving distance from the central office to the edges of the network should not significantly exceed an hour. A network covering Addison and Rutland counties can meet this criteria; for example, Orwell is within an hour drive of Pawlet (to the south) and Starksboro (to the north).

It should be noted that while WCVT's offices in Hinesburg and Waitsfield Vermont are within an hour's driving distance of towns in the Addison region, the same cannot be said for towns in the Rutland region. Thus, If WCVT were interested in operating a combined district, it may need to build a location for infrastructure support services to serve a combined CUD.

Using an Operational Partnership to Expand Network Size

Forming an operational partnership to expand the size of the network while maintaining the CUD's independence (and ability to secure a VEDA loan) would require the Addison and their partner CUD:

- Coordinate RFPs for construction, maintenance, and operation
    - Respondents should bid on operation of both CUDs as one
    - May require a separate contract between each CUD and RFP respondent
- Construct their networks with the understanding that they will be operated by the same entity
    - Coordinate on hub locations
    - Use uniform standards and mechanism for construction
    - Use the same brand(s) of equipment and electronics
    - Contract with the same entities for internet backhaul sharing a central hub location for purposes of redundancy and economies of scale. Internet backhaul per GB prices decrease with larger purchases.
        - *Note: the project team recommends all CUDs coordinate through the Vermont CUD Association (VCUDA) and attempt to aggregate purchasing power*
- Share resources and coordinate to gain efficiency moving forward
    - Purchasing / negotiations
    - Website and brand name
    - Equipment, contractors, consultants,plans for network maintenance as needed

Once build-out is complete and VEDA loans repaid, there may be little reason to remain separate CUDs and a merger may make ongoing operation easiest.

Benefits of an Operational Partnership or Merged District

There are several benefits to forming an operational partnership or outright merging with another CUD. First, larger districts are more attractive to operators, and the CUD may receive more favorable responses to their RFPs. Second, a larger network is more attractive to private investors, which may allow the CUD to secure subordinated debt at more favorable rates. Finally, a shared network allows the sharing of fixed costs over a larger number of customers, increasing margins of the network and mitigating risk.

Operational Partnership vs. Merged District

Both an operational partnership or a merged network are viable paths towards building a FTTP network in the region; in both the merged district and operational partnership scenarios, the CUD will benefit from increased scale. The primary advantage of an operational partnership is that each CUD will likely be able to receive a $4 million VEDA loan. Additionally, each CUD

board may be able to be more attentive to the needs of its constituents under an operational partnership. The primary drawback of an operational partnership compared to a merged district is increased complexity. The CUDs must coordinate closely to put out RFPs at the same time, select the same network operator, and design and construct the networks with interoperability in mind (e.g., use the same brand of equipment).

Potential Drawbacks of a Larger Network

While larger fiber networks benefit from economies of scale, there are some potential downsides to a larger network. While a network consisting of Addison and Rutland counties would not be too large geographically, a larger network (whether in the form of an operational partnership or a merged district) will be more complicated. Additionally, some CUD members may feel being in a larger network dilutes local decision making and control. CUD board members can mitigate this concern by remaining attentive to the needs of their constituents, being clear to the public about the benefits of a larger district, and being transparent about projected build timelines and the build sequence so constituents understand when they will likely receive service, and why the timeline is such.

Effect of an Operational Partnership on Build Speed

Truth be told, it is hard to fully predict the effect of a partnership on the build speed of both networks. Clearly, serving towns as fast as possible is a priority for all CUDs. This study's calculations estimate that under an operational partnership, each CUD will be able to complete 200 miles of make-ready each year, compared to 250 miles a year if both are operating independently. That being said, GMP owns the majority of the poles in the region, and both CUDs will likely request make-ready work at similar times, even if they are operating independently. As such, any bottlenecks in completing make ready work due to an operational partnership requesting a lot of make-ready all at once might also occur if the CUDs operated independently.

The project team advocates that the CUD maintain open lines of dialog with legislators and DPS to advocate for policies that decrease potential make-ready bottlenecks, and keep officials informed of those bottlenecks if they occur.

For documentation on how the Independent and Partner models affect how many towns are built each year, please see Appendix C.

Network Operator

Finding and selecting an experienced network operator and negotiating a mutually satisfactory relationship will be the District's most important decision. Most importantly, this relationship will dramatically affect the ability of the District to attract financing. Though all operators will want to see the results of the feasibility study and business plan, as well as see the successful full formation of the CUD before submitting formal operating proposals, discussions are ongoing with a range of entities that could eventually become the operator. As the CUD

indicated, they are open to learning about all operating models and structures at this point, with a preference towards models that allow them to retain some control over the quality of service provided to member towns. In general, CUDs must balance risk and control. If the network operator/partner contributes to the financing of the network, that reduces the risk the CUD takes on, but this also results in some loss of control for the CUD, as the operator/partner would own a portion of the network.

To achieve a successful project within the parameters of the financing options available and with the interests of Addison CUD member towns in mind, the operator should:

- Exist currently as a business entity, and have proven experience delivering a utility or telecom service to customers
- Be able to leverage a range of current assets, systems and experience, from system construction, customer service/phone/billing systems, to experienced executive leadership
- Have a business structure, accounting experience, and compliance acumen, and motivation to secure flexible, disparate, and sometimes challenging funding opportunities, including bonds, loans, grants, and other sources
- Be willing to work for lower profits than those attainable in less rural (denser) areas (i.e., possibly a non-profit, B Corporation, or similar)
- If the Addison CUD decides to enter a operational partnership with another CUD, the operator must be prepared to serve both CUDs

From a potential operator's perspective, a CUD must make itself attractive by by having the following characteristics:

- Have the scale to present a sufficiently profitable opportunity
- Be adequately financed
- Be willing to commit to a multi-year (likely 5 year) exclusive operating contract, subject to termination if objective operating standards are not met
- Have robust pre-subscriptions for service (i.e., evidence of sufficient demand) and be willing to help with local marketing efforts
- Be realistic about the amount of control it will exert on day to day operations.

Entering into an operational partnership with another CUD will make the Addison CUD an attractive opportunity for potential operators by:

- Increasing the number of potential customers and therefore ultimate revenue opportunities
- Introducing new efficiencies, e.g., more customers can be served per central office, technicians, and hub locations
- Mitigating risk, as the project will not rely on overbuilding as many cabled areas in order to reach viable scale

The primary portion of the operating protocols for a successful partnership between a District and an operator is summarized below:

I. General Principles

1. The Project network (the "Network") shall be universal and financially self-sustaining.
2. The Network shall offer, within operational limits, 'net-neutral' Internet access (i.e. not linked to any specific browser, not filtered or blocked).
3. The Network's day-to-day operations shall be delegated, according to the terms of the Operation Agreement to the Operator, including, but not restricted to Rollout, Connection, Pricing, Marketing, Personnel Issues and Customer Service.

4. The Network's connection fees shall be standardized for all new subscribers, with the following exceptions:

- Sales Promotions;
- Subscriber connections exceeding Standard 400 ft aerial drops.
- Such other circumstances as exigencies may require – but only with the consent of the District Governing Board.

II. General Roles regarding the Project

A. District

a. Formulate and articulate general governance policies
b. Oversee District accounts
c. Monitor Operator performance
d. Due diligence and approval regarding budgets, major contracts and agreements
e. Interface with investors
f. Sign contracts above a stipulated amount; delegates to the Operator the right to sign contracts below a stipulated amount.

B. Operator

a. Execute and complete the Network project including designing, building all associated Network assets and operating them as an ongoing business.
b. Acknowledge and comply with District policies
c. Manage Network operations, monitoring availability, ensuring security, and coordinating with contracted backhaul internet providers
d. Report regularly on Network project progress and operations
e. Promptly inform District of changes or difficulties

Ultimately it is up to the CUD to decide which provider best fits their desired governance and operational model. As needed, RISI and ValleyNet will continue to provide assistance to the Addison CUD to help them vet potential providers until they select a partner.

Potential Partner: Waitsfield and Champlain Valley Telecom

WCVT has indicated that they are open to working with or partnering with the Addison CUD. This partnership could take several forms.

First, the Addison CUD could partner with WCVT to share the cost of connecting to the broader internet (backhaul). Backhaul is a significant expense, so such a partnership would decrease costs for the CUD. Relatedly, WCVT has additional resources that could prove useful to the CUD, such as central office space or storage space, and relationships with vendors (e.g, Calix, an equipment manufacturer), and a partnership to share costs of these elements would be beneficial to both entities.

Second, WCVT may be willing to keep the CUD appraised of their construction plans, so that the CUD does not make plans to overbuild future WCVT fiber. Because WCVT can overlash fiber to their existing copper lines in many cases, they would likely be able to build more quickly than the CUD; thus, the project team recommends that the CUD does not attempt to "race" WCVT to build fiber to areas of overlap between the CUD and WCVT ILEC territory. In fact, WCVT has already built many of the densest, central town areas in their territory, making a build by the CUD even harder in those towns.

Finally, WCVT remains open to a more extensive public-private partnership with the CUD to accelerate fiber build-out to the more rural areas, where premises are far apart. For example, WCVT and the CUD could create a similar partnership to the one Consolidated Communications has created with several towns in New Hampshire: CCI and the towns both invested financial capital in the network, CCI operates the network, and CCI charges an additional fee to customers to pay back the town's general obligation bond. While CUDs cannot access general obligation bonds, they can access VEDA loans, subordinated debt, and revenue bonds. In this kind of public-private partnership, the CUD would benefit from the financial capital invested by the partner but would also lose some control over the network. The CUD could help accelerate deployment and could structure the public-private partnership to ensure even the most rural residents are served by fiber.

In addition to joint ownership of infrastructure in its ILEC territory, WCVT is interested in operating a fiber network in the rest of Addison county; the CUD would likely fund and own all infrastructure outside of WCVT's ILEC territory.

Benefits of a Public-Private Partnership with WCVT

Under a public-private partnership (PPP), the CUD would own and finance the infrastructure and yet not have direct responsibility for operations. In this scenario, the CUD would not have to worry about economies of scale (such as reaching 5,000 customers) because they would be effectively leveraging the existing customer base of an already operational and successful network. The CUD would benefit from economies of scale in purchasing equipment and

services, as well as in operations. A PPP with an existing provider also reduces the risk of overbuilding in a competitive environment and would dramatically improve penetration in areas already served by the provider. The CUD would also benefit from lower capital expense and faster build times in these areas covered by the provider, because the cost and time to do make-ready would be dramatically reduced. If this model is an interesting possibility it should and will be modeled in detail in the Business Plan using inputs based on the real circumstances of the specific private partner. The project team will work with both the CUD and WCVT to model PPP structures that adhere to CUD legal requirements, provide suitable profit to the partner and cover the CUD's debt service and insurance needs, are suitable to potential financiers, and allow the CUD to ensure their mission to provide good service to constituents is able to be fulfilled.

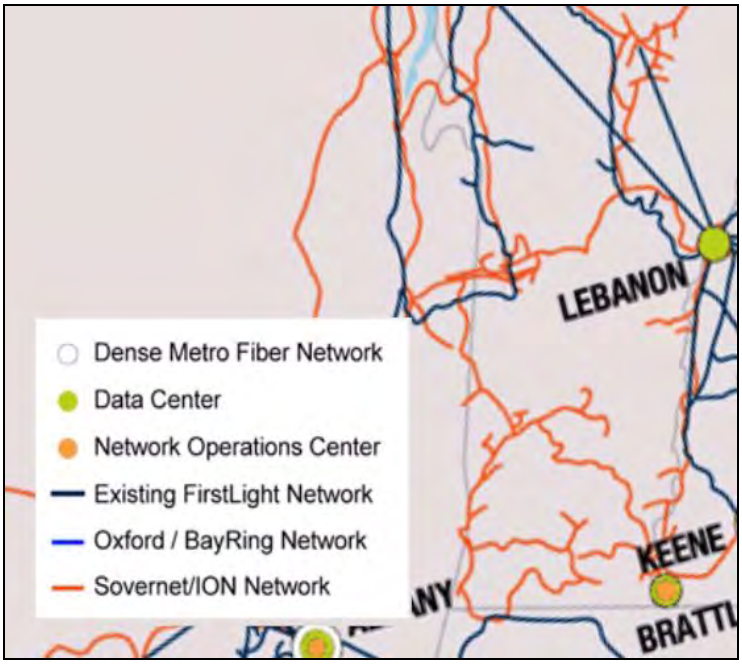
Technical Feasibility

There is nothing about the region that would hinder the technical feasibility of a multi-town FTTP system. The existing infrastructure in the region will not present any barriers to creating a viable and detailed engineering plan for the region at a later stage in the process.

Backhaul Availability

The first technical hurdle the network needs to clear is determining where access to fiber backhaul is relative to the network. Backhaul refers to the fiber infrastructure needed to carry information between the core and the edge, between a regional network's router location to the "carrier hotel" where it connects to the greater global Internet network. Fortunately, the Addison CUD will have a choice in the matter, with Firstlight, Consolidated Communications, and VELCO (Vermont Electric Power Company) all indicating interest in being the backhaul provider for the network. CenturyLink also has fiber availability from Albany, NY to Burlington, VT through western Vermont. This will allow the Addison CUD to compare proposals and pick the backhaul provider that best suits their needs, or multiple providers to establish redundancy in the network.

As a result of the FirstLight acquisition of Sovernet, FirstLight has available fiber assets in Vermont connecting educational institutions and commercial properties. Their network reaches into 8 of the 21 towns in the Addison County Region studied here. In addition, FirstLight has interconnections to the Internet at major carrier hotel facilities in Boston, Springfield, Albany, NYC, Portland, and Montreal which would allow for multiple paths of egress (note: these interconnections are not shown on the map).



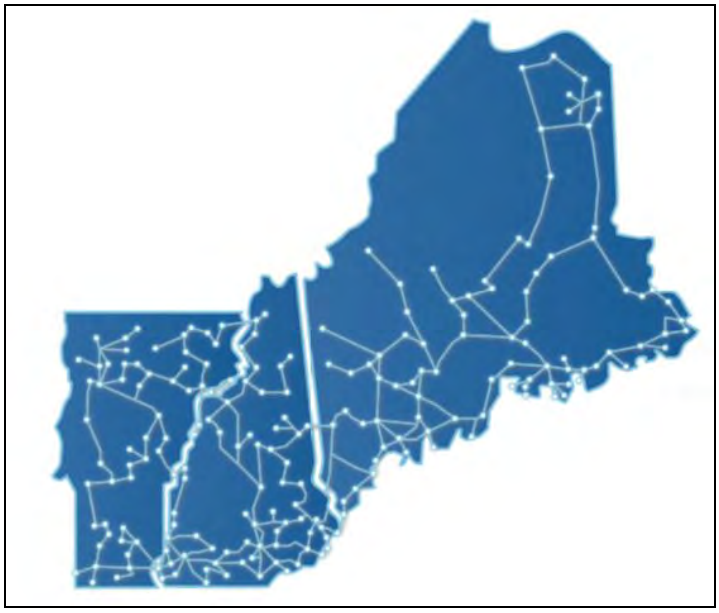
Firstlight Fiber Network

Another option for middle mile fiber and backhaul is the Vermont Electric Power Company (VELCO), which owns, with the other electric companies, a network of fiber along transmission lines through Vermont. This network has many strands of unused fiber and has been eager to be a partner to fiber projects in the state. VELCO's reach is also quite extensive in the Addison County Region, and could accommodate a variety of build plans. Although this appears to be contrary to the recent Magellan Report[21] on the feasibility of electric utility involvement in broadband, recent meetings with VELCO have indicated a real desire to be a part of the VT broadband solution.

[21] "Feasibility Study of Electric Companies Offering Broadband in Vermont," https://publicservice.vermont.gov/announcements/psd-releases-feasibility-study-electric-companies-offering-broadband-vermont

VELCO Fiber Network

In addition, Consolidated Communications has fiber assets within the region that could be used for backhaul to the Internet or hub connections.



Consolidated Communications Fiber Network

CenturyLink has available fiber connecting co-location facilities in New York City to Albany and Montreal, with fiber from Albany to Bennington and then Burlington. This fiber could provide some redundancy to the internet backhaul.

CenturyLink Fiber Network

The fiber availability in all of these networks could eventually be utilized to connect the various communication union districts together to create redundancy in the networks, to connect hub locations, and to aggregate services for further cost savings.

All of these options would provide appropriate and sufficient backhaul to the network, and existing fiber lines are located in enough towns in the region to allow for construction of the underserved areas of the region first, with multiple deployment routes to choose from.

Additional existing fiber assets

FirstLight, VELCO, and Consolidated Communications have available fiber along the main thoroughfares in the Addison County Region. VELCO (Vermont Electric Power Company) was established in order to create and maintain an interconnected electric transmission grid. In order to do so, VELCO needed to connect all facilities with optical fiber to manage and monitor the electrical facilities. As a result, on many parts of their fiber network they have excess fiber.

Although it is unlikely this fiber could be used for distribution (connection directly to premises), it could be used to connect geographically separated towns in the early phases of construction and connect hubs and build resiliency and redundancy in the fully built broadband network. It also could be used to connect Communication Union Districts or other broadband networks together for redundancy and possible cost savings. Consolidated Communications has a fiber network that connects all DSL equipment hubs back to their central offices. In addition, CCI often delivers fiber network access to large commercial entities.

Lastly, many of the Town offices and emergency services are located in buildings with backup generator power. These locations make excellent hub sites for the network.

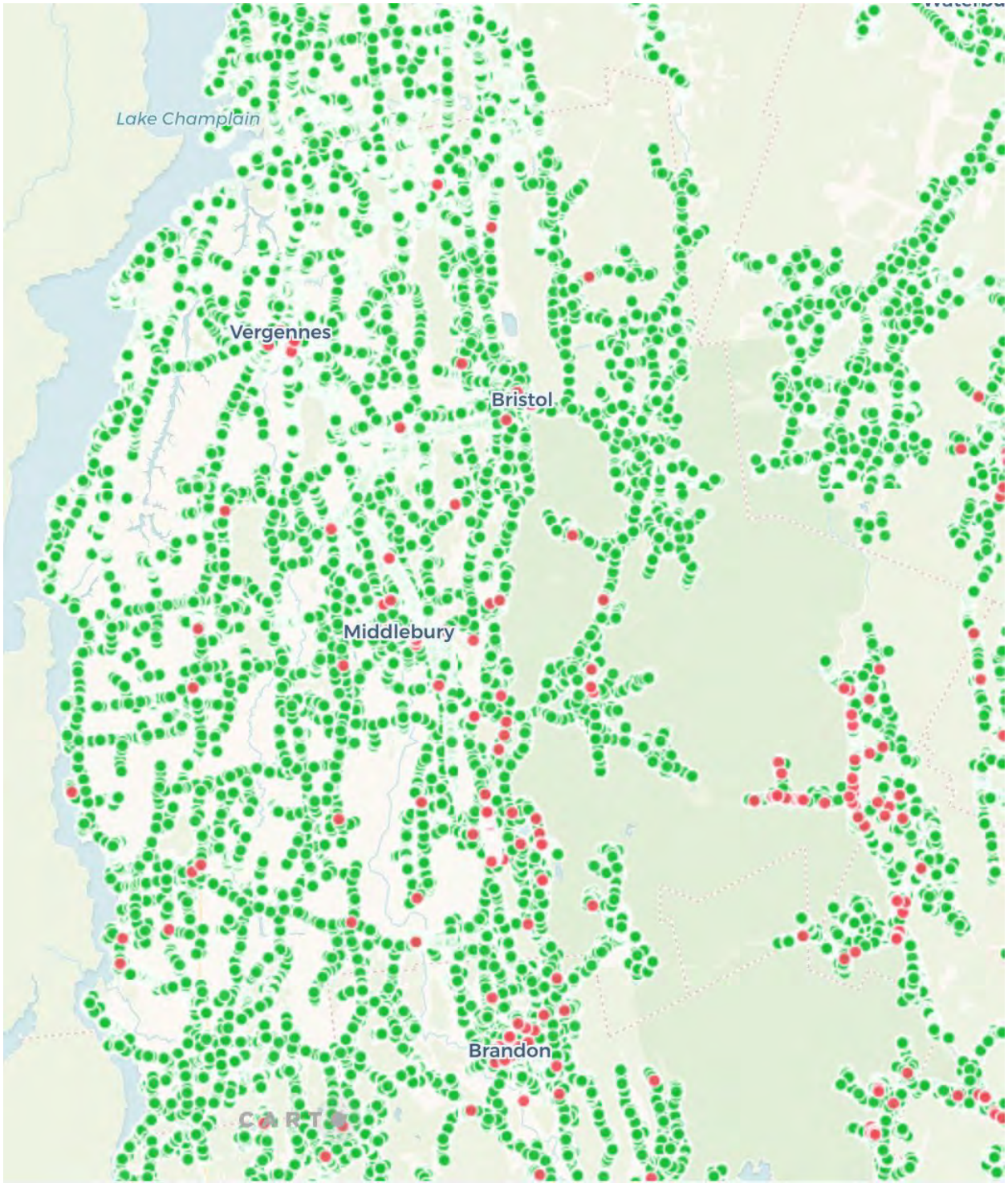
Utility poles in the region

Because our study is focused on the deployment of Fiber-to-the-Premise and not wireless solutions or other mechanisms for providing broadband, the only important vertical infrastructure are utility poles.

Green Mountain Power (GMP) provides data on their utility poles through the Vermont Geodata Portal; as such, this data identifies locations and characteristics of poles, including pole height and pole class. Extremely old poles, which tend to be under 30 feet, and poles that have 2 or more attachees in the communications space will more often need to be fully replaced to be used for fiber attachment, increasing the cost of deployment.

The average cost to make space on the pole for a new fiber attachment in a Vermont rural area where there are few attachments on the pole is $100-$200 per pole. This translates to an average cost of $5,000 per mile (assuming roughly 30 poles per mile). That amount potentially triples in cabled and densely populated areas where there are multiple attachees on a pole and pole replacements (costing upwards of $1000 per pole) are more likely. Vermont instituted new pole attachment rules last year, including one-touch make-ready in the communication space. This new option should help to reduce make-ready costs and delays overall.

What follows is a map of GMP pole locations in the Addison County Region. Green poles are 30’ and higher, red poles less than 30’.



Green Mountain Power pole locations in the Addison County

In total, only about 2,500 of the state's 298,000 utility poles (less than 1%) are likely in need of replacement due to being too short, and in Addison county, that number is closer to .5% based on the current Green Mountain Power pole database. Even then, fiber will not be attached to

every pole, and determining exactly how many poles need to be replaced will occur when an exact deployment route is being created and make-ready conditions for each pole are negotiated with utilities on a joint "rideout."

In addition, the cable route data published by the Vermont DPS allows the model to estimate the percentage of poles that are likely to be more crowded, which increases the cost of deployment. These numbers are all factored into the construction cost projections below.

In order to gain access to the utility poles in the right-of-way, the Addison CUD will also need to obtain a Certificate of Public Good. This Certificate of Public Good authorizes an entity to provide telecommunications services and can be obtained from the Vermont Public Utility Commision.

Underground Construction

A few miles of utility cable and copper infrastructure in each town will likely be underground. The fiber network will follow the same route and underground conduit will need to be installed, often in the Town's road right-of-way. Underground construction is several times more costly than aerial construction and can be very difficult in Vermont's rocky terrain. Without a detailed design it is impossible to predict exactly what percentage of the network construction is underground, but ECFiber's experience is that it averages less than 5% of total mileage and has not significantly impacted build costs in the state of Vermont. Each Town has its own permitting process for use of the Town right-of-way. They are often different from each other. Documenting that process in advance will be very useful when the CUD is ready to install underground utilities.

Bandwidth needs

Based on the bandwidth needs of the ECFiber network, bandwidth needs for the fully operational Addison CUD are estimated to be 20 Gbps, split between 2 network router hubs with egress to the Internet (10 Gb at each location). However, this is all scalable. The network would be built initially with 3-5 Gb backhaul and increase capacity as needed as more users come on-line.

Basic Network Design

An optical fiber Gigabit Passive Optical Network (GPON) with distributed splitting in the field is recommended. GPON networks have become the standard for municipal broadband and for Fiber-to-the-Premise projects in the US. The infrastructure is scalable and is limited only by the equipment on both ends of the fiber. The fiber network is future-proof; as increased bandwidth and capacity are necessary, the electronic equipment can be upgraded without needing to rebuild the base fiber architecture. The initial network will consist of a hub location in each town connected to each other with 10 Gb fiber transport, eventually creating interconnecting,

redundant rings. The initial design will include two central hub locations that will also house the routing equipment to access the Internet. These two locations will provide redundancy, in the case of a failure, for each other. Home equipment (e.g, Internet routers) will also be gigabit compatible. Assuming the Addison CUD does create an operational partnership with a neighboring CUD, the second major hub location may be unnecessary as redundancy will be provided by the other CUD (or, perhaps, the two CUDs could share 3 major hubs).

An alternative fiber network option is an Active Ethernet Optical Network (AON). This network would dedicate a strand of fiber from the hub location to each premises. This type of network is not recommended because more fiber would need to be deployed throughout the network, increasing construction and operation costs for very little additional customer benefit.

Build Sequence

Due to the ample backhaul options and general condition of the utility poles in the region, the project team is able to recommend the following build sequence. First the CUD will build in unserved towns first (Phase I) followed by mostly unserved towns where a small portion of the town is cabled (Phase IA). Next, the CUD will connect unserved areas in the *partially* cabled towns (Phase II). In Phase II, it is estimated that 20% of the cabled miles in a given town will need to be built to reach unserved areas; the CUD will likely lure some customers away from cable during Phase IA and Phase II.

Finally, the CUD may overbuild the remaining portions of these towns to capture customers from coaxial cable companies (Phase III); the project team does not recommend that the CUD overbuild the small portions of the region already served by fiber. The feasibility model demonstrates a network that overbuilds in towns with higher density in cabled areas: Ferrisburg, Waltham, Weybridge, Monkton, Starksboro, Bristol, Middlebury, Leicester, and Vergennes. This is not intended to be an inflexible plan for the exact path the CUD should take. Rather, the CUD should focus on reaching unserved areas first and then selectively overbuilding cabled areas based on factors such as demonstrated demand and density.

There is flexibility in the following sequence both in terms of the exact order of towns, which towns are overbuilt, and the speed at which the network gets built (more information on build speed is in the Financial Feasibility Findings section). The final order of build will be determined in the engineering and design phase.

Build Sequence					
	VT DPS # Buildings	Served with fiber or cable	cabled miles	uncabled miles	
	748	0.00%	0	75.0	Phase I
Whiting	185	0.00%	0	20.0	Phase I
Shoreham	741	13.50%	6	73.4	Phase IA
Bridport	662	16.47%	7	63.7	Phase IA
Cornwall	582	18.90%	8	38.0	Phase IA
Salisbury	877	15.28%	7	33.9	Phase IA
Ripton	377	9.55%	1	27.8	Phase IA
Addison	853	45.13%	25	32.2	Phase II
Panton	330	53.64%	13	11.1	Phase II
Ferrisburg	1667	56.21%	38	45.3	Phase II
Waltham	225	52.44%	6	7.7	Phase II
New Haven	820	65.12%	39	25.3	Phase II
Weybridge	409	43.52%	10	23.3	Phase II
Monkton	905	74.70%	32	20.9	Phase II
Starksboro	916	69.54%	23	20.8	Phase II
Lincoln	682	64.81%	27	24.6	Phase II
Bristol	1600	94.25%	39	10.6	Phase II
Middlebury	2926	95.76%	64	19.5	Phase II
Leicester	699	96.28%	24	4.3	Phase II
Vergennes	1017	100.00%	14	0.8	
				Ferrisburg	Phase III
				Waltham	Phase III
				Weybridge	Phase III
				Monkton	Phase III
				Starksboro	Phase III
				Bristol	Phase III
				Middlebury	Phase III
				Leicester	Phase III
				Vergennes	Phase III

Apart from financial limitations, ValleyNet's experience in Vermont is that building more than 250 miles in a given year is logistically difficult due to the speed at which pole owners can perform make-ready work. This limit could perhaps increase in the future if make-ready regulations increase the speed and reliability of make-ready work by the utilities. However for the purposes of this study it is assumed that 250 miles per year is the limit to what can be built.

If the Addison CUD pursues an operational partnership with another CUD, we estimate that the utilities could complete about 400 miles per year across both regions. As more CUDs are created and require make-ready work, there is a risk of delays; this is addressed more thoroughly in the risk management portion of the feasibility study.

Inputs Used in Financial Feasibility Calculation

The preliminary financial feasibility analysis for universal coverage has been developed with a range of inputs informed by historical data.

Again, the purpose of this work is to produce a high-level determination of the project's feasibility. Due to the similarities in demographics, density, geography, and scale between the Addison County Region and the service area of ECFiber, the project team has relied largely on historical data from the ECFiber network to determine if a similar approach could work in the Addison County Region. Construction cost assumptions are based on data from both the most recent ECFiber expansions and the ongoing build of LymeFiber in Lyme, NH. Due to COVID-related factory closures and tariffs on Chinese goods, materials costs have recently increased. Construction labor prices have also gone up, due to increased demand for skilled labor. The feasibility study incorporates these increased costs.

Revenues and expenses are based on a historically consistent take rate, ARPU, EBITDA margin (varying by size of system) and capital expenditure (varying by type of build and customer). Determining a baseline of feasibility will allow us to refine the exact business model in the subsequent grant phase.

Importantly, ECFiber's operator agreement with ValleyNet is fairly unique and is perhaps not representative of what other operators may charge. We have adjusted this expense to represent 3% of gross revenues, or $75,000, whichever is more. If the selected operator requires a different structure or higher/lower percentage of revenues than 3%, the financials may need to be further adjusted.

The EBITDA margins are generally representative of ECFiber's margins at similar stages of development. One primary difference is the cost of backhaul — because consumer bandwidth needs have increased since ECFiber built its network, the feasibility model assumes the Addison CUD will offer service tiers at 50/200/800 Mbps, which is higher than the service ECFiber currently offers of 25/100/300/800.

The model uses the following key assumptions:

Penetration rates

The project team has elected to use historical data from ECFiber CUD's network to calculate penetration rates (also called take-rates) by year in our model. We have adjusted the penetration rates to reflect increased subscription due to COVID-19. COVID-19 has created a significant increase in subscriptions and service tier upgrades. While it is uncertain whether

customers who requested higher service tiers will keep that service once the pandemic is over, it is safe to assume that most new customers will stay with fiber rather than reverting to their previous internet provider moving forward.

Penetration rate assumptions are as follows:

	Penetration by Year	
year	cabled	uncabled
1	11.0%	22.0%
2	17.9%	35.8%
3	22.0%	44.0%
4	24.8%	49.5%

In the first year, it is assumed that construction occurs an average of mid-way through the year, leaving fewer months for people to sign up and receive service. After year 4, customers increase at 3% each year, a rate which eventually then declines as the network reaches saturation of market demand. These numbers can be enhanced by factoring in other demographic data, like median income levels by town, but are sufficient for the feasibility analysis.

For context, these assumptions would result in an overall penetration rate for the Addison CUD of 38% of PSD premises in year 10 (vs. ECFiber's current penetration rate is at 30%, 9 years after starting operations). Because of the surge in subscriptions since March, ECFiber has enough demand (assuming 85% of pre-subscribers become customers) to reach 42% penetration in areas without cable or fiber competition in the next 12-18 months.

The ECFiber footprint is very similar in terms of household income compared to the Addison County footprint (with 2018 data, the most recent available from the American Community Survey, the ECFiber towns averaged $66,500 per household while median household income in Addison county was $65,000). That being said, ValleyNet has performed a regression analysis on its penetration rates for fully built towns relative to their median household income, and years in service were more important than median incomes. Penetration rates in ECFiber towns also varied significantly based on other factors — most particularly in whether the town ran a pre-subscription campaign and whether there were one or more local/neighborhood champions supporting the project.

Average Revenue Per User (ARPU)

It may seem that a survey is a good tool to determine what users would be willing to pay for a service. This type of survey — called a "willingness to pay" survey, is notoriously hard to execute and hard to obtain significant results. Typically, when surveys ask in the abstract about

what customers would pay for service or what they deem is fair, customers respond with a lower than what they might truly pay. It is much easier to volunteer a number in theory than open your wallet and pay in reality. In the broader field of economic and market research, economists and researchers hesitate to use willingness to pay survey answers in analyses.

As such, in order to estimate the Average Revenue per User, we took historical ECFiber data and incorporated a cushion. ECFiber's service tiers start at $72/month for the Basic tier and increase at higher speeds. 46% of customers choose a plan faster than Basic's 25/25 Mbps speeds, which means that actual average revenue per customer, including people who subscribe to phone service (>60% take phone service for $25 per month), business service, and higher tiers of residential service, is $110/month. The feasibility study conservatively uses a starting ARPU of $105 per month — approximately 5% less than ECFiber's actual ARPU. APRU declines slightly over time as the proportion of customers subscribing to a phone service decreases

Revenue, Expense, Capital Expenditure, and Financing Assumptions:

A. **REVENUE**
   a. Penetration
      i. Based on years of service and status of mileage (served or unserved)
   b. ARPU/Pricing — "Double Play" Product Offering — Internet and Phone (No video packages) — resulting in a starting Average Revenue per User of $105/month with:
      i. Internet speed — 3+ tiers
      ii. Phone service — includes all features and unlimited long distance
      iii. Mix of Residential/business Customers (90%+ residential)
      iv. Business customer rates (higher to account for higher service expectations)
      v. Installation fees — $99 for aerial installation (or underground with usable conduit) less than 400 ft

ECFiber Service Tiers and Rates

	***** 2019 AND PRIOR ******				****** SINCE 2/1/20 *****			
	RESIDENTIAL		*BUSINESS*		*RESIDENTIAL*		*BUSINESS*	
	Mbps	Price	Mbps	Price	Mbps	Price	Mbps	Price
Basic Internet	25	$74	25	$80	25	$72	30	$90
Standard	50	$99	50	$109	100	$104	100	$124
Ultra	200	$124	200	$134	300	$134	300	$159
Wicked	700	$149	700	$207	800	$164	800	$250
Phone		$20		$30		$25		$35

incl. unlimited Long Distance Calling and all features				
Voicemail	$3	$3	Included with Phone Service	
Static IP Address	N/A	$7	N/A	$7

These rates resulted in an average revenue per customer per month of $110 for ECFiber in Q1/2020 – excluding installation revenue.

B. **EXPENSE*** — Average operating expenses based on ECFiber experience, including:
   a. Phone service — $7-9 per customer per mo
   b. Internet backhaul — based on traffic volume
   c. Pole Rental — ~$10 per pole per year - recently reduced from $15
   d. Personnel/Benefits
      i. Outside Plant — partially capitalized
      ii. Installation — partially capitalized
      iii. Customer service
      iv. Administration and Finance
      v. Technical
   e. Other Expenses
      i. Rent
      ii. Insurance
      iii. Regulatory
      iv. Legal
      v. Network maintenance — contracted
      vi. Other — utilities, supplies, vehicle maintenance, bad debt
      vii. Operator "profit" assumed at 3% of gross revenues or $75,000 a year, whichever is less

*Actual expenses in early years could vary greatly depending on the extent of an operator's existing operations and the terms of the contract between the CUD and the operator — these assumptions will need to be solidified in a more formal business plan.

C. Capital Expenditures — Assumptions based on the ECFiber experience, including:
   a. Pole Data Collection/FTTP Design and Engineering Costs
      i. $1,300 per mile
   b. Pole Make-Ready (unserved and cabled areas)
      i. $5,000 per mile in unserved areas, $15,000 in cabled areas
   c. Electronics/Hubs
      i. "Calix" brand equipment assumed
      ii. Hub sites — one per town
      iii. Main Routers (2 to start)
      iv. Laser transceivers/networking electronics at hubs

v. Customer Premise Equipment — $300 per customer included in the Drop and Installation Costs.

d. Capital Construction/Splicing Costs — including capitalized labor and replacement costs

Capital Expenditures a+b+c+d average $28,000 per mile in unserved areas and $38,000 in cabled areas

e. Drop and Installation Costs — including capitalized labor
   i. Approx. $1400 per customer
   ii. Drop — connecting/splicing from road to premise
   iii. Installation Costs — CPE, In-home wiring and customer education

D. Financing Terms for VEDA loans, subordinated debt and (non-recourse) revenue bonds

	Interest Rate	Term	Seniority
VEDA Loans	4%	5 yrs	Senior
Subordinated Debt	8-9%	N/A	Junior
Revenue Bonds	5-6%	23-28 yrs	Senior*

*assumes VEDA loans paid down by first Revenue Bond offering

Sources of Financing

For the purpose of this feasibility study, three primary sources of financing were considered:

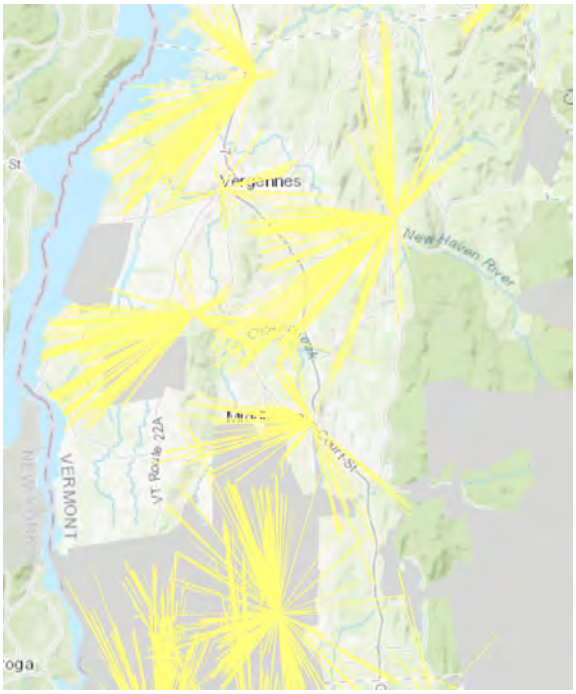
1) Vermont Economic Development Authority (VEDA) loans to CUDs as recently authorized by the Vermont legislature.
   a) $4M per CUD with 10% match requirement
   b) 5 year term, interest rate assumed to be 4%, assumed balloon repayment
   c) Interest payments can be deferred for up to two years
2) Subordinated Debt raised from private investors
   a) High interest rate — accrued, not cash pay (8% assumed), junior to both VEDA loan and revenue bonds (below)
   b) Replaced by lower interest revenue bonds when possible
3) Municipal Revenue Bonds — ECFiber has issued $42M of these bonds from 2016-2019
   a) Non-recourse to the CUD/towns, investors have recourse ONLY to revenues of the system in case of default
   b) 6% interest rate, declining to 5% — lower rate for later tranches (lower risk)
   c) 3 years interest only
   d) 23-28 year maturity

Rural Utility Service (RUS) Loans

RUS loans are administered through the USDA; these loans typically have a 2-3% interest rate with a 20 year term. Much of Vermont is ineligible for these loans due to a previous funding for Vtel to build a wireless “canopy” in the state. Fortunately, while portions of Addison county are ineligible due to grants to VTel and Waitsfield Telecom, large portions of Addison county were not covered by this grant, and therefore may be eligible. That being said, VTel has applied for additional RUS funding, which could hinder the CUDs ability to take advantage of a RUS loan.

Below is a map of prior USDA grant areas (gray) and pending applications (yellow).

RUS grant eligibility



Even in areas not covered by previous grants/loans, Addison County may not meet all the eligibility criteria.

- At least 15% of households must be unserved for the area to be eligible.
    - The USDA defines “served” having access to 10 Mbps download and 1 Mbps upload, which is a lower bar than the FCC’s definition.
    - While the region is well covered by DSL — which ISPs often claim to have speeds of 10/1 — the USDA allows applicants to challenge the speed claims of ISPs.
    - Parts of the Addison region may be eligible if DSL service does not consistently reach 10/1 speeds.

- For an area to be eligible, “no part of the proposed funded service area has three or more ‘incumbent service providers.’”
- “Proposed funded service areas must be completely contained within a rural area or composed of multiple rural areas, as defined in 7 CFR 1738.”

Finally, RUS loans may need to be senior to all other loans, meaning they could not be taken out concurrently with the VEDA loan, which also must be the senior loan. In this case, the CUD would still need to take on subordinated debt.

If the CUD is able to secure a RUS loan, this would lower the cost of capital, and may make a project in the Addison County Region alone feasible. Furthermore, Addison does partner or merge with another CUD, a low-interest loan would still be beneficial to the project. The project team recommends that the CUD closely monitor and consider their eligibility for a RUS loan.

Other financing sources that could be available in the near future, and can be evaluated in the Business Plan phase should that occur:

1) State Grants
    a) Connectivity Initiative
    b) New COVID-19 recovery plans
2) Unused, Available (Dark) Fiber
    a) If Vermont could provide dark fiber along major routes with local distribution access points (similar to that built by the Vermont Telecommunications Authority) that would be helpful for both middle mile and local distribution — unfortunately, Vermont does not own fiber with local distribution access points in Addison county.[22]

Financing sources not currently viable for this project:

3) FCC Rural Digital Opportunity Fund (RDOF) Reverse Auction
    a) This program provides support to broadband carriers to build unserved areas in a reverse auction format, where winning bidders promise to deliver broadband and voice services at the lowest cost
    b) CUDs aligned with qualified partners may benefit from this auction.

Financial Feasibility Findings

There are three critical thresholds in the trajectory of the network’s finances important to consider when determining the project’s feasibility.

[22] https://publicservice.vermont.gov/content/map-fiber-owned-department-public-service

First, the network must become EBITDA (Earnings Before Interest Taxes Depreciation and Amortization) positive. It is the Public Service Department's strong desire that this occur within 3 years after the start of deployment for the network to be considered feasible. For reference, in ECFiber's experience, this occured as the network reached approximately 1,000 customers (5 years in service).

Second, it is important to calculate when the network can maintain revenue bond debt service covenants of 1.25X EBITDA. This threshold is the point at which revenue bonds can be raised to pay back startup loans/subordinated debt and fund the full expansion of the network.

Third, the overall health of the project can be assessed by comparing the entire project's Internal Rate of Return (IRR) to the cost of capital. The IRR must clearly exceed the cost of capital for the project to be viable.

To understand when the network would reach the thresholds listed above, the project team calculated the trajectory of the network under two scenarios:

- Scenario 1: Addison CUD operates independently
- Scenario 1a: Addison CUD partners with an incumbent telephone provider
- Scenario 2: Addison creates an operational partnership with a neighboring CUD

In both scenarios, the project team needed to rely on the use of subordinated debt to enable the network to expand faster than the VEDA loan alone would allow.

Scenario 1: Addison CUD operates independently

In this scenario, the project team found that:

- CUD reaches 1,000 customers in year 3 and 5,000 customers in year 7.
- Viability is contingent upon CUD being able to achieve a take-rate of 22% in cabled areas (after 4 years of service in that area) with starting ARPU of $105.
- **$22.7M** of subordinated debt is required in years 1-4 to accelerate the build to quickly reach enough customers to cover operating margins.
- EBITDA positive result occurs in year 3.
- **While the CUD initially reaches 1.25X EBITDA coverage in year 5, it cannot sustain this ratio in the long run**
- **The CUD will have an Internal Rate of Return of about 4.6%. This is lower than the cost of capital, which is about 5%, meaning the CUD will not be financially sustainable.**

Scenario 1a: Addison CUD partners with an existing provider

The Addison CUD could also create a feasible network by partnering with an existing provider in the same region, such as WCVT. Benefits of such a public private partnership include:

- Lower construction costs and increased speed of deployment in the incumbent provider's territory
- Higher take-rates in the incumbent provider's territory
- Presence of existing leadership team and staff
- Economies of scale in purchasing equipment and services
- Less pressure to build in an aggressive and risky way to reach economies of scale suitable for justifying operations

This scenario can be modeled in full in the business planning phase with the benefit of more information from WCVT on their operations, costs, and requirements for being an operator. As WCVT has focused on bringing FTTP in their more densely populated areas, a partnership with a CUD could bring the capital resources to provide FTTP to those more rural, sparsely populated areas ensuring universal access for the entire region. This partnership would have mutual benefits to WCVT, with the potential of also bringing more resources to bear on the construction of the areas of overlap between the ILEC territory and CUD member towns. WCTV also benefits by the possibility of a higher ARPU on a FTTP network, higher customer satisfaction, and an increased take-rate.

Scenario 2: Addison CUD creates an operational partnership

To model this scenario, this report assumed a partnership with Otter Creek CUD. This partnership would include all towns in the Addison Region, as well as most towns in the Rutland region (excluding towns covered by VTel's FTTP network).

The Addison CUD would be well suited to partner with Otter Creek CUD considering Otter Creek's first towns and the Rutland Region's most unserved towns are adjacent to the Addison Region. Furthermore, the driving distance across the two regions is not so great as to hinder timely customer service.

In this scenario, the network can reach sufficient scale without overbuilding all cabled areas. The CUD is advised to make overbuilding decisions on a case-by-case basis, evaluating factors such as density and demonstrated demand. In addition to overbuilding the cabled areas in the Addison region listed in the Build Sequence, several areas of the cabled towns in the Rutland region will be overbuilt.

To be clear, these hypothetical partnerships have not been agreed upon by any parties, although both CUDs have indicated they are open to potential partnerships. This model assumes an operational partnership, where both CUDs receive a VEDA loan. The network would also be viable as a merged CUD with one VEDA loan; the CUD would need to borrow more

subordinated debt. Additionally, the project team has found that a network made up of towns in Addison and Rutland, *excluding* towns covered by WCVT, is also viable. The model excluding these towns represents a scenario whereWCVT is able to serve those towns with fiber in a timely manner before the Addison/Rutland CUD is able to do so, avoiding a CUD overbuild.

Because the operator is shared, we will refer in some cases below to thresholds the operator will achieve, not just that the CUD will achieve.

With an operational partnership, the project team found that:

- Operator reaches 1,000 customers in year 3 and 5,000 customers in year 5.
- A take rate of 22% in cabled areas (after 4 years of service in that area) is assumed with a starting APRU of $105; viability is significantly less dependent on overbuilding cabled areas.
- EBITDA positive result occurs in year 3.
- The operator will reach 1.25X EBITDA coverage by year 5, allowing them to access revenue bonds to continue construction.
- $30 M of subordinated debt is required in years 1-4 to achieve sufficient early construction.
- The operator would have an IRR of 5.6% This is higher than the cost of capital, and thus is financially sustainable.

The following is a comparison of the independent vs operational partnership scenarios over 10 years.

Comparison INDEPENDENT v PARTNER

		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Miles	INDEPENDENT		174	412	633	762	878	878	878	878	878	878	878	878	878	878
	PARTNER		354	654	922	1,177	1,424	1,756	1,756	1,756	1,756	1,756	1,756	1,756	1,756	1,756
Passings	INDEPENDENT		1,674	4,905	8,105	10,987	15,991	15,991	15,991	15,991	15,991	15,991	15,991	15,991	15,991	15,991
	PARTNER		3,646	7,925	11,667	16,635	24,355	39,816	39,816	39,816	39,816	39,816	39,816	39,816	39,816	39,816
New Miles	INDEPENDENT		174	238	221	128	116	0	0	0	0	0	0	0	0	0
	PARTNER		354	300	268	255	247	332	0	0	0	0	0	0	0	0
Customers	INDEPENDENT		357	1,236	2,374	3,413	4,582	5,269	5,670	5,945	6,123	6,307	6,496	6,691	6,891	7,098
	PARTNER		784	2,137	3,581	5,112	6,853	9,592	11,292	12,349	13,043	13,435	13,838	14,253	14,680	15,121
New Customers	INDEPENDENT		357	879	1,138	1,039	1,169	687	401	275	178	184	189	195	200	207
	PARTNER		784	1,353	1,444	1,531	1,741	2,739	1,700	1,057	694	392	403	415	427	441
Customers Per Mile	INDEPENDENT		2.1	3.0	3.7	4.5	5.2	6.0	6.5	6.8	7.0	7.2	7.4	7.6	7.8	8.1
	PARTNER		2.2	3.3	3.9	4.3	4.8	5.5	6.4	7.0	7.4	7.7	7.9	8.1	8.4	8.6
Penetration	INDEPENDENT		21%	25%	29%	31%	29%	33%	35%	37%	38%	39%	41%	42%	43%	44%
	PARTNER		22%	27%	31%	31%	28%	24%	28%	31%	33%	34%	35%	36%	37%	38%
EXPENSES	INDEPENDENT	(250)	(562)	(1,001)	(1,959)	(2,611)	(3,117)	(3,308)	(3,360)	(3,454)	(3,496)	(3,564)	(3,650)	(3,745)	(3,839)	(3,951)
	PARTNER	(250)	(697)	(1,835)	(3,047)	(3,919)	(4,663)	(5,690)	(6,506)	(7,077)	(7,385)	(7,592)	(7,775)	(7,978)	(8,179)	(8,417)
EBITDA	INDEPENDENT	(250)	(450)	-	529	1,209	2,094	2,943	3,489	3,767	3,962	4,095	4,215	4,332	4,454	4,566
	PARTNER	(250)	(450)	-	823	1,815	3,133	5,064	6,756	7,718	8,371	8,722	8,979	9,227	9,489	9,726
Debt	INDEPENDENT	2,280	10,026	20,229	30,383	38,844	45,126	47,352	47,198	47,005	46,269	45,212	43,906	42,473	40,941	39,311
	PARTNER	2,940	16,143	29,215	42,792	58,318	73,871	86,800	88,964	87,647	86,119	84,019	81,532	78,828	75,939	72,869
Sub Debt incl accrued	INDEPENDENT	1,080	6,026	16,229	26,383	25,644	24,926	16,152	5,233							
	PARTNER	540	8,143	21,215	34,792	33,818	32,871	21,300	6,901							
Debt Service Coverage	INDEPENDENT					1.67	1.95	1.81	1.61	1.37	1.36	1.29	1.22	1.20	1.23	1.25
	PARTNER					1.35	1.44	1.49	1.6	1.51	1.52	1.43	1.37	1.37	1.4	1.43

Factors the could change the viability determination

The broadband landscape is rapidly changing. While many potential developments represent risks to the project (and are discussed thoroughly in the "Project Risk" section), there are developments that could improve the financial outlook of the Addison CUD, and perhaps even allow Addison CUD to operate independently. In addition to the Addison CUD securing a RUS loan or partnering with an existing provider, other developments that would aid the CUD include:

- The VEDA loan program may expand from $20M to $40M, meaning $8M of loans with a more favorable interest rate are available per CUD.
- The state may make additional grants available, perhaps using COVID-related stimulus funds.
- Build costs may decrease as factories closed due to COVID-19 start to re-open and fiber supply increases.
- The RDOF winner may be willing to partner with the Addison CUD and share RDOF funds.
- Take-rates may increase further due to the pandemic.
- The Addison CUD may find an ISP willing to operate the network for less than 3% of revenues.

Conclusion of Financial Feasibility Analysis

Under an operational partnership or merger, the network would have a stronger financial position, reaching 1.25x EBITDA coverage in year 5. Perhaps more importantly, the network will be more resilient to risks, such as an incumbent cable ISP lowering prices or an unfavorable outcome in the RDOF auction. Potential risks and mitigation strategies are discussed more thoroughly in the Project Risks section.

Ultimately, we find that an independent Addison CUD is not feasible without an additional, low interest loan or a partnership with an existing provider in the region. This study strongly recommends pursuing either a public private partnership with an existing provider or an operational partnership or a merger with another CUD.

Pre-Subscription Campaign

In addition to prioritizing unserved areas first, and to choosing a compatible operator, a third key tactic to increase the network's viability is to use a pre-subscription campaign. A pre-subscription campaign collects subscription information from people who desire service (including choosing Internet speeds and phone service and acknowledging pricing), and does not require a deposit or any guarantee beyond a digital signature.

Pre-subscription campaigns allow a provider to understand where there is the most interest, which can inform where to build first (within technical feasibility). More importantly, it also allows the fiber build crews to hook up houses as they pass them rather than needing to make a second trip to a location, thereby saving time and money. And finally, all sources of financing will appreciate seeing significant pre-subscription numbers (as opposed to theoretical survey results); strong numbers will make it easier to secure loans and grants.

In ECFiber's experience, 85% of pre-subscriptions become paying customers, with the remainder realizing that their long driveway requires additional connection fees for conduit installation, or moving, or signing a long term contract with another operator. ECFiber was able to achieve higher rates of penetration in areas that ran an intensive pre-subscription campaign — although these results were also influenced by town demographics and dedicated town leadership.

Based on ECFiber's experience, both the pre-subscription campaign and the issuance of subordinated debt (primarily with local investors because VT residents can take full advantage of the double tax free nature of the interest) would serve to make the issuance of revenue bonds more achievable. This is because outside investors view both robust pre-subscription totals and local debt issuance as demonstration of community commitment.

To achieve the maximum impact of the pre-subscription campaign, it should be enacted after the Business Plan (phase 2 of the BIG grant process) is complete.

Third Party Opinion

Municipal Capital Markets, a nationwide financier of a variety of infrastructure, community, and municipal projects including broadband, has reviewed this work. They believe our assumptions are credible and have issued a letter to that effect, which includes a stated desire to explore working with the CUD when they are ready to issue revenue bonds. Municipal Capital Markets also expressed to the project team that in their opinion, enacting a Public-Private Partnership with a local provider in the region (like Waitsfield Champlain Valley Telecom) is the best path for the CUD to take. Their letter of approval can be found in Appendix C.

Project Risks

Any project of this scale involves risks that need to be monitored and evaluated on an ongoing basis. The biggest risks are as follows.

RDOF Auction

An important source of uncertainty in this project is the upcoming Rural Opportunity Digital Fund reverse auction. In this auction, the FCC will disburse up to $20.4 billion to

telecommunications carriers to subsidize broadband deployment in underserved areas, including a range of areas in Addison County. Only census blocks where no locations are served are eligible for RDOF funding; 9.6% of unserved locations in the Addison County Region are eligible for RDOF funding. Compared to other regions, a smaller proportion of unserved locations in Addison are eligible for RDOF funding, which mitigates this risk.

Unfortunately, CUDs or even the state of Vermont have no control over who receives this federal money, so the RDOF auction may result in the expansion of a provider into the area that goes counter to the CUD's intentions for providing universal fiber coverage.

Potential outcomes include:

- An incumbent telephone provider wins the bid with a VDSL product on their existing copper assets. Although this will increase competition in the region, it is unlikely to change the Addison CUD's approach or feasibility outlook, as VDSL does not offer the same level quality and capacity as fiber.
- The RDOF winner (e.g. incumbent telephone provider, private network company) serves RDOF locations with a FTTP network and *partners* with the CUD to build remaining areas. This public-private partnership would be able to access state resources such as the VEDA loan. Such a partnership may change the build sequence slightly in order to prioritize serving RDOF locations, but could be a favorable outcome nonetheless.
- The RDOF winner serves RDOF premises with a FTTP or coaxial cable network and is not interested in partnering with the CUD. RDOF locations would now be "served," changing the CUD business plan to build them later in the process or not at all. This scenario represents the greatest risk to the CUD, and can be considered the "worst case scenario."

In the "worst case scenario," where RDOF premises are served by cable or fiber, we found that **a network consisting of the Rutland and Addison CUDs together is still feasible.** The CUDs would have less room for error in this scenario though, as the internal rate of return is lower at 5.0%.

Competitive Response

Portions — about 60%— of the Addison region already have access to cable or fiber internet. At some point, the CUD will need to overbuild some cabled areas in order to reach a critical mass of customers. Incumbent cable providers may respond by dropping prices, which would affect the CUDs take-rate. In some areas in smaller Vermont towns, cable providers have not changed their prices in response to a new wired service provider, but in other areas, such as Burlington, cable companies have dropped prices significantly to try to compete for customers. Such uncertainty may also make it more difficult to secure subordinated debt, as lenders are more inclined to support networks in mostly uncabled areas.

Incumbent Telephone Fiber Expansion

Two incumbent telephone providers (ILECs) in the region, Waitsfield Telecom and OLTELCO, have small fiber networks. While these networks are currently small, these companies may plan to expand their fiber networks, especially as it becomes increasingly clear that DSL does not offer adequate speeds.

Consolidated Communications has also indicated they will build fiber networks in Vermont, which could represent competition; that beings aid, Consolidated Communications is already burdened with significant debt,[23] which may hinder its ability to invest in fiber infrastructure.

First, the CUD should explore whether one of the ILECs could be the partner/operator of the Addison CUD's network. As described in the Network Operator section, WCVT has expressed interest in partnering with the Addison CUD.

Merging with a neighboring CUD is also an effective way to mitigate this risk, as a larger network will include more unserved areas and will therefore have a greater cushion against fiber expansion; for example, a network including towns in Addison and Rutland that *excludes* towns covered by WCVT would still be financially viable.

Construction Cost Inflation

Construction costs have already increased significantly due to factory closures and tariffs — a fact which is incorporated into this study. It is possible that construction costs increase more in the coming months. If the limited number of fiber broadband construction firms are suddenly in demand all around the country the construction and deployment costs could grow exorbitantly due to the increased demand for these services. (This was the case in 2012 with the American Recovery and Reinvestment Act broadband projects. Lead time for the delivery of optical fiber went from 4-6 weeks to 4-6 months in a very short period of time and the price also escalated reflecting that demand).

At this point, the CUD should continue to project that the price of construction and materials will stay at its current levels (rather than assuming costs will come down as factories return to normal production). There is no way to know if and when costs will decrease.

To account for higher construction costs, the CUD should stay alert for different sources of capital that could give the CUD more of a cushion. With infrastructure — and in particular broadband infrastructure — being discussed as a priority for COVID-19 recovery, there is a chance that greater resources might be available to fiber broadband projects across the country in the fall or beyond. There is also a chance that CUDs will be able to access low interest USDA RUS loans in the future, which would partially mitigate the effects of increased construction costs.

[23]https://www.globenewswire.com/news-release/2020/04/30/2025176/0/en/Consolidated-Communications-Reports-First-Quarter-2020-Results.html

Make-Ready or Construction Delays

Any delay in deploying fiber in any portion of a planned build (either due to pole make-ready delays or construction capacity constraints — see above) can sometimes delay service on many other miles of completed network. With CUDs forming all at once across the state and needing the same work and services performed, including pole data collection, make-ready work, construction, and more, this could cause a shortage of qualified labor and/or delay in completion of work.

In 2019, the governor of Vermont signed HB 513 into law, which in addition to creating the BIG Grant and the VEDA broadband loans, also included a provision to facilitate the make-ready process. The new regulation states that if make-ready work is not completed on-schedule, after 30 days the pole owner must refund payment for uncompleted work, and the network constructor can hire a qualified contractor to complete the remaining make-ready work. Hopefully this new regulation will reduce delays.

Even if everything proceeds according to schedule, there is a limit to the amount of make-ready work that can be completed in a given year. GMP owns most poles in the region, and with several CUDs begining broadband deployment at the same time, GMP may be unable to keep up with make-ready requests. ValleyNet has had discussions with both GMP and the Department of Public Service, who are aware of the situation; GMP believes it has sufficient crews to handle multiple new Districts.

The only surefire solution to this involves state policymakers providing funding or incentives to support make-ready work. This involves both support to increase GMP's capacity and potentially support to increase the local capacity of private construction and technician groups like Eustis Cable via Vermont Training Grants or other programs. The Addison CUD should take every opportunity to inform legislators of this risk and keep the Department of Public Service appraised of make-ready progress.

Failed Execution

The operating company selected to run the network could fail to adequately control the construction and operation of the network. Failure could be due to any number of reasons — mismanagement, overextension, continuing broader economic shock or recession, or other — but the results would be damaging. Though the contract between the CUD should be written in a way to protect the CUD and the deployed fiber asset and give the CUD the option of finding a new operating partner, such an event would delay and disrupt service and erode trust between the towns and the CUD, and between the customers and the CUD.

Take Rate Variability

Due to the current unemployment and economic slowdown, which may or may not last until fiber starts to be deployed, historical penetration data is not as robust. The penetration data used in this study is based on mid-pandemic numbers, which could continue to increase even into the recovery phase, or could subside to previous levels. A pre-subscription campaign will

be a clearer indicator of projected take-rates and encourage financial investment in the network.

Additionally, determining the take-rate for cabled areas is even harder because the incumbent provider may respond by dropping their prices, or they may not. Unfortunately, it is difficult to predict exactly how competitors will behave. If the Addison County Region operates jointly with another region, the project will still be viable, even if the take rate in cabled areas is lower than expected.

Conclusion

The Addison County Region BIG project team believes this document is accurate and credible and represents our best judgement as to the feasibility of a Fiber-to-the-Premise network in the Addison County region. We strongly advise the Addison CUD to form a partnership with an existing provider or a neighboring CUD in order to decrease the risk of the project. Partnering with another CUD would mean the project can better overcome challenges such as a competitive response from an incumbent cable provider or an unfavorable RDOF outcome.

RISI and ValleyNet want to stress that even when pursued in coordination with a neighboring CUD or an existing provider, this project will continue to require great effort on the part of CUD leadership, a responsiveness to continued changes in our country's economic, political, and public health landscape, successful fundraising, finding the right operator partner, and ongoing attention to minimizing costs.

At this juncture, the project team recommends that the Addison CUD focuses on adding towns in the Addison region and exploring a partnership or merger with a neighboring CUD. The CUD should also continue conversations with potential operators/partners. Finally, the CUD can begin to assess which areas, if any, are eligible for a low-interest loan from the USDA.

This is not an easy time to be building a new fiber network from the ground up. The volatility of the economic and political landscape, as well as the ongoing pandemic, do not make this an easy task. The project team is committed to helping Addison keep their head on a swivel and adjust mid-course as new information becomes available. The Addison CUD has built a capable and responsive team, and we look forward to continuing with the CUD as they plan and eventually govern a fiber network in the region.

Appendix A: Independent scenario

		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Miles			191	429	650	779	895	895	895	895	895	895	895	895	895	895
Passings			1,815	5,046	8,246	11,128	16,132	16,132	16,132	16,132	16,132	16,132	16,132	16,132	16,132	16,132
Customers		-	**388**	**1,287**	**2,436**	**3,483**	**4,654**	**5,343**	**5,746**	**6,023**	**6,204**	**6,390**	**6,582**	**6,779**	**6,982**	**7,192**
average			194	838	1,862	2,960	4,069	4,999	5,545	5,885	6,114	6,297	6,486	6,681	6,881	7,087
per mile			2.0	3.0	3.7	4.5	5.2	6.0	6.4	6.7	6.9	7.1	7.4	7.6	7.8	8.0
penetration			21%	26%	30%	31%	29%	33%	36%	37%	38%	40%	41%	42%	43%	45%
ARPU	$ 105		$105.00	$104.69	$104.37	$104.06	$103.75	$103.43	$103.12	$102.81	$102.51	$102.20	$101.89	$101.59	$101.28	$100.98
($000s)					$ 104											
Revenue			**200**	**1,232**	**2,561**	**3,905**	**5,299**	**6,342**	**6,942**	**7,316**	**7,556**	**7,760**	**7,969**	**8,183**	**8,403**	**8,630**
Service revenue			122	1,052	2,331	3,696	5,065	6,204	6,861	7,260	7,520	7,723	7,930	8,144	8,362	8,588
Installation revenue	$ 200		78	180	230	209	234	138	81	55	36	37	38	39	41	42
Expenses		(250)	(572)	(1,052)	(2,017)	(2,669)	(3,170)	(3,356)	(3,406)	(3,499)	(3,542)	(3,611)	(3,698)	(3,794)	(3,890)	(4,003)
EBITDA		**(250)**	**(450)**	**-**	**544**	**1,236**	**2,130**	**2,986**	**3,536**	**3,816**	**4,015**	**4,149**	**4,271**	**4,389**	**4,513**	**4,626**
EBITDA Margin				*0%*	*21%*	*32%*	*40%*	*47%*	*51%*	*52%*	*53%*	*53%*	*54%*	*54%*	*54%*	*54%*
Interest VEDA		(48)	(160)	(160)	(160)	-	-	-	-	-	-	-	-	-	-	-
Interest Rev Bonds		-	-	-	-	(726)	(1,076)	(1,626)	(2,163)	(2,413)	(2,375)	(2,320)	(2,253)	(2,179)	(2,100)	(2,016)
Principal VEDA		1,200	2,800			(4,000)	-	-	-	-	-					
Principal Rev Bonds		-	-	-	-	12,408	6,580	10,340	10,105	4,710	(736)	(1,057)	(1,306)	(1,433)	(1,532)	(1,630)
Principal Sub Debt - less 3% issuance		970	4,365	8,730	7,954	(2,638)	(2,564)	(9,970)	(11,306)	(5,233)	-	-	-	-	-	-
Capex		(1,402)	(6,703)	(8,491)	(8,564)	(6,435)	(4,519)	(1,319)	(954)	(817)	(725)	(779)	(839)	(903)	(975)	(1,053)
FCF/IRR	*4.6%*	*(1,652)*	*(7,153)*	*(8,491)*	*(8,019)*	*(5,199)*	*(2,390)*	*1,667*	*2,582*	*3,000*	*3,290*	*3,369*	*3,431*	*3,485*	*3,538*	*3,573*	*23,130.7*
Cash Flow		470	(148)	79	(225)	(155)	550	411	(782)	64	179	(7)	(127)	(125)	(93)	(73)
Cash Balance		**470**	**322**	**401**	**176**	**21**	**572**	**983**	**201**	**265**	**444**	**438**	**311**	**185**	**92**	**19**
rev bond issuance						13,200	7,000	11,000	11,000	5,500						
FINANCINGS																
VEDA Total	principal	1,200	2,800			(4,000)	-	-	-	-	-					
balloon at end of yr 4	interest	(48)	(160)	(160)	(160)	-	-	-	-	-	-					
	balance	1,200	4,000	4,000	4,000											
Rev Bond Total																
3 yrs interest only	principal	-	-	-		13,200	7,000	11,000	10,765	5,040	(736)	(1,057)	(1,306)	(1,433)	(1,532)	(1,630)
s Debt Svc Reserve Fund (3%) and	issuance (3%)			-	-	(792)	(420)	(660)	(660)	(330)	-	-	-	-	-	-
	interest	-	-	-	-	(726)	(1,076)	(1,626)	(2,163)	(2,413)	(2,375)	(2,320)	(2,253)	(2,179)	(2,100)	(2,016)
	balance	-	-	-	-	13,200	20,200	31,200	41,965	47,005	46,269	45,212	43,906	42,473	40,941	39,311
Subordinated Debt																
	principal	1,000	4,500	9,000	8,200	(2,638)	(2,564)	(9,970)	(11,306)	(5,233)						
	balance	1,080	6,026	16,229	26,383	25,644	24,926	16,152	5,233							
Total Debt		**2,280**	**10,026**	**20,229**	**30,383**	**38,844**	**45,126**	**47,352**	**47,198**	**47,005**	**46,269**	**45,212**	**43,906**	**42,473**	**40,941**	**39,311**
Debt Service Rev Bonds				**-**	**-**	**(726)**	**(1,076)**	**(1,626)**	**(2,163)**	**(2,748)**	**(2,915)**	**(3,180)**	**(3,461)**	**(3,611)**	**(3,632)**	**(3,646)**
EBITDA Coverage	**must be > 1.25X**					**1.70**	**1.98**	**1.84**	**1.63**	**1.39**	**1.38**	**1.30**	**1.23**	**1.22**	**1.24**	**1.27**

Appendix A: Partnership scenario

			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	
Miles				354	654	922	1,177	1,424	1,756	1,756	1,756	1,756	1,756	1,756	1,756	1,756	1,756	
Passings				3,646	7,925	11,667	16,635	24,355	39,816	39,816	39,816	39,816	39,816	39,816	39,816	39,816	39,816	
Customers			-	**784**	**2,137**	**3,581**	**5,112**	**6,853**	**9,592**	**11,292**	**12,349**	**13,043**	**13,435**	**13,838**	**14,253**	**14,680**	**15,121**	
average				392	1,461	2,859	4,347	5,983	8,223	10,442	11,821	12,696	13,239	13,637	14,046	14,467	14,901	
per mile				2.2	3.3	3.9	4.3	4.8	5.5	6.4	7	7.4	7.6	7.9	8.1	8.4	8.6	
penetration				22%	27%	31%	31%	28%	24%	28%	31%	33%	34%	35%	36%	37%	38%	
ARPU	$105			$105.00	$104.69	$104.37	$104.06	$103.75	$103.43	$103.12	$102.81	$102.51	$102.20	$101.89	$101.59	$101.28	$100.98	
($000s)						$104												
Revenue				**404**	**2,105**	**3,870**	**5,734**	**7,796**	**10,754**	**13,262**	**14,795**	**15,756**	**16,315**	**16,754**	**17,205**	**17,668**	**18,144**	
Service revenue				247	1,835	3,581	5,427	7,448	10,206	12,922	14,584	15,617	16,236	16,673	17,122	17,582	18,055	
Installation revenue	$200			157	271	289	306	348	548	340	211	139	78	81	83	85	88	
Expenses			(250)	(697)	(1,835)	(3,047)	(3,919)	(4,663)	(5,690)	(6,506)	(7,077)	(7,385)	(7,592)	(7,775)	(7,978)	(8,179)	(8,417)	
EBITDA			**(250)**	**(450)**	**-**	**823**	**1,815**	**3,133**	**5,064**	**6,756**	**7,718**	**8,371**	**8,722**	**8,979**	**9,227**	**9,489**	**9,726**	
EBITDA Margin					*0%*	*21%*	*32%*	*40%*	*47%*	*51%*	*52%*	*53%*	*53%*	*54%*	*54%*	*54%*	*54%*	
Interest VEDA			(96)	(320)	(320)	(320)	-	-	-	-	-	-	-	-	-	-	-	
Interest Rev Bonds			-	-	-	-	(1,348)	(2,173)	(3,398)	(4,223)	(4,500)	(4,420)	(4,311)	(4,183)	(4,044)	(3,895)	(3,737)	
Principal VEDA			2,400	5,600			(8,000)	-	-	-	-	-						
Principal Rev Bonds			-	-	-	-	23,030	15,510	23,030	15,543	5,194	(1,528)	(2,100)	(2,487)	(2,704)	(2,889)	(3,070)	
Principal Sub Debt - less 3% issuance			485	6,790	11,155	10,670	(3,479)	(3,382)	(13,148)	(14,910)	(6,901)	-	-	-	-	-	-	
Capex			(2,395)	(11,303)	(11,004)	(11,150)	(12,007)	(13,377)	(11,500)	(2,770)	(1,909)	(1,443)	(1,068)	(1,135)	(1,209)	(1,288)	(1,377)	
FCF/IRR	*5.60%*		*(2,645)*	*(11,753)*	*(11,004)*	*(10,327)*	*(10,192)*	*(10,244)*	*(6,437)*	*3,986*	*5,810*	*6,928*	*7,655*	*7,844*	*8,019*	*8,201*	*8,350*	*48,632.48*
Cash Flow			144	317	(169)	23	11	(288)	48	396	(397)	981	1,244	1,174	1,272	1,417	1,544	
Cash Balance			**144**	**461**	**292**	**315**	**326**	**38**	**86**	**482**	**85**	**1,066**	**2,310**	**3,484**	**4,756**	**6,173**	**7,717**	
rev bond issuance							24,500	16,500	24,500	17,000	6,500							
FINANCINGS																		
VEDA Total	principal		2,400	5,600			(8,000)	-	-	-	-	-						
balloon at end of yr 4	interest		(96)	(320)	(320)	(320)	-	-	-	-	-	-						
	balance		2,400	8,000	8,000	8,000												
Rev Bond Total																		
3 yrs interest only	principal		-	-	-		24,500	16,500	24,500	16,563	5,584	(1,528)	(2,100)	(2,487)	(2,704)	(2,889)	(3,070)	
s Debt Svc Reserve Fund (3%) and	issuance (3%)				-	-	(1,470)	(990)	(1,470)	(1,020)	(390)	-	-	-	-	-	-	
	interest		-	-	-	-	(1,348)	(2,173)	(3,398)	(4,223)	(4,500)	(4,420)	(4,311)	(4,183)	(4,044)	(3,895)	(3,737)	
	balance		-	-	-	-	24,500	41,000	65,500	82,063	87,647	86,119	84,019	81,532	78,828	75,939	72,869	
Subordinated Debt																		
	principal		500	7,000	11,500	11,000	(3,479)	(3,382)	(13,148)	(14,910)	(6,901)							
	balance		540	8,143	21,215	34,792	33,818	32,871	21,300	6,901								
Total Debt			**2,940**	**16,143**	**29,215**	**42,792**	**58,318**	**73,871**	**86,800**	**88,964**	**87,647**	**86,119**	**84,019**	**81,532**	**78,828**	**75,939**	**72,869**	
Debt Service Rev Bonds					**-**	**-**	**(1,348)**	**(2,173)**	**(3,398)**	**(4,223)**	**(5,121)**	**(5,511)**	**(6,108)**	**(6,554)**	**(6,747)**	**(6,784)**	**(6,807)**	
EBITDA Coverage	**must be > 1.25X**						**1.35**	**1.44**	**1.49**	**1.6**	**1.51**	**1.52**	**1.43**	**1.37**	**1.37**	**1.4**	**1.43**	

Appendix B: Build Sequence, Miles, Pasings

Build Sequence						INDEPENDENT		PARTNER	
	VT DPS # Buildings	Served with fiber or cable	cabled miles	uncabled miles		Miles Built	year	Miles Built	year
Orwell	748	0.00%	0	75.0	Phase I	75	2	75	2
Whiting	185	0.00%	0	20.0	Phase I	95	2	95	2
Shoreham	741	13.50%	6	73.4	Phase IA	174	2	174	2
Bridport	662	16.47%	7	63.7	Phase IA	71	3	71	3
Cornwall	582	18.90%	8	38.0	Phase IA	117	3	117	3
Salisbury	877	15.28%	7	33.9	Phase IA	158	3	158	3
Ripton	377	9.55%	1	27.8	Phase IA	187	3	187	3
Addison	853	45.13%	25	32.2	Phase II	224	3	224	3
Panton	330	53.64%	13	11.1	Phase II	238	3	238	3
Ferrisburg	1667	56.21%	38	45.3	Phase II	53	4	291	3
Waltham	225	52.44%	6	7.7	Phase II	62	4	300	3
New Haven	820	65.12%	39	25.3	Phase II	95	4	33	4
Weybridge	409	43.52%	10	23.3	Phase II	120	4	58	4
Monkton	905	74.70%	32	20.9	Phase II	147	4	86	4
Starksboro	916	69.54%	23	20.8	Phase II	173	4	111	4
Lincoln	682	64.81%	27	24.6	Phase II	203	4	30	5
Bristol	1600	94.25%	39	10.6	Phase II	221	4	49	5
Middlebury	2926	95.76%	64	19.5	Phase II	32	5	81	5
Leicester	699	96.28%	24	4.3	Phase II	41	5	90	5
Vergennes	1017	100.00%	14	0.8					
					Ferrisburg - Phase III	71	5	120	5
					Waltham - Phase III	76	5	125	5
					Weybridge - Phase III	84	5	133	5
					Monkton - Phase III	110	5	26	6
					Starksboro - Phase III	128	5	44	6
					Bristol - Phase III	32	6	32	7
					Middlebury - Phase III	82	6	82	7
					Leicester - Phase III	101	6	101	7
					Vergennes - Phase III	116	6	113	7

Note: In partner scenario, miles only refer to miles in the Addison Region

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May 12th, 2020

Stan Williams
Chief Financial Officer
Valley Net
415 Waterman Rd.
Royalton, VT 05068

RE: Letter of Interest to finance the Addison & Rutland Broadband Communication Union Districts Projects.

Dear Stan:

Municipal Capital Markets Group (MCM) has been funding the East Central Vermont Telecommunications District (ECFiber) since 2015 and look forward to continuing our financial support of building fiber infrastructure in rural Vermont. After review of the Addison and Rutland Project's Feasibility Study, MCM is interested in financing the infrastructure much like the ECFiber's network, provided that the new district can achieve what is anticipated in the Feasibility Study.

MCM believes the assumptions made in the Feasibility Study including network construction costs, penetration (adoption), average rate per user, etc. is viable and realistic to serve the rural markets in Vermont. To that end, the project satisfies MCM's main investment objectives and allows us to leverage our unique position with experience in Broadband, USDA-Rural Development, and underwriting / selling non-rated revenue bonds.

Sincerely Yours,

Christopher R. Perlitz
Managing Director
Municipal Capital Markets Group, Inc.
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Member: FINRA & SIPC

Cc: James Anderson, Mgr. Director, MCM

Appendix D: Glossary of Broadband, Telecom, and Finance Terms

1G/10G/100G	Short for 1/10/100 Gigabits per second connection speed
Accrued Interest	Interest that is not paid in cash, but 'accrued' and added to principal balance
Active E/EPON	Provides a direct link to each premise without splitters – more expensive to build than GPON
ADSL	a.k.a. DSL – an asymmetric Internet connection over copper with download speeds much higher than upload
ADSS fiber	All Di-electric Self Supporting fiber – does not require strand – often used in the electrical space since it is non-conductive
Aerial Drop	Drop that is all above ground on poles
ARPU	Average Revenue per Unit – a standard telecom metric measuring the average revenue derived each month from a customer
Attenuation	Measure of the loss in signal strength due to distance, splicing, bends, etc
Backhaul	Refers to an ISP's connection from their network to the broader Internet - (In wireless networks, how data is transmitted to/from a cell site – wireless backhaul is typically insufficient to offer 1Gbps speeds – fiber backhaul is the standard for most cell sites
Balloon Repayment	The repayment of a loan or bond in one lump sum at the end of its maturity – i.e., principal not amortized over time
Bandwidth Overbooking	A practice whereby an ISP calculates the average peak usage for backhaul and buys that amount (rather than the max speed offered to each customer) – if overdone to reduce expenses, this can degrade a customer's experience of the full speeds for which they are paying (at peak hour)
Cabled	A road that has cable service delivering (asymmetric) Internet over coaxial cable
Capex per Customer	Varies by build cost, density and penetration rate

Capex per Passing	Capital cost required to pass – varies by build cost and density
Carrier hotel	Also called a colocation center, a carrier hotel is a physical site where networks from multiple communications providers converge and are interconnected
Conduit	Pipe or tubing through which cables can be pulled or housed – usable conduit for pulling fiber is typically 2+" in diameter and must have rounded sweeps – i.e., fiber cannot be bent at a sharp angle without a large attenuation in signal strength
Cost of Goods Sold	Variable cost of providing service – for ISPs, this includes wholesale cost of phone service, Internet backhaul, video (if offered) and sometimes pole rental
Customer	A residence or business that is receiving service
Customers per Mile	Ann alternative to Penetration Rate which takes into account the density of the network
Dark Fiber	Fiber that is in place on the poles but not "lit" by electronics at either end – allows companies to buy/lease fiber infrastructure rather than an actual connection
Debt Service Covenant	An agreement with provider of debt to maintain debt service at a certain level – ex., EBITDA must be > 1.25X Debt Service – if a covenant is breached the owner of the debt can take certain pre-negotiated steps to bring the debt into compliance or, under extreme conditions, may be able to take control of the debtor
Debt Service Coverage	A standard financial ratio measuring the ability to service interest and principal payments on debt = EBITDA / Debt Service (Interest and Principal) for a given time period (usually annually)
Density	Linear Density of an area = homes per mile of network
Dig Safe	A service provided at no charge by utilities to mark where underground plant is before a homeowner/contractor can dig (dial 811)
Distributed Splitting	32 way splitter located in the field (not the hub) – reduces fiber count
Distribution Fiber	Typically 12-24 strands used from a DSP to a FAP for local distribution
Double Play	Internet and Phone

Drop	The connection from the road to a premise
DSP/FSA	Digital Split Point (Fiber Service Area = area served by the DSP) – the point in the network where the signal is split 32 ways for final distribution
EBITDA Margin	EBITDA divided by revenue as a percentage
EBITDA	Earnings Before Interest Taxes Depreciation and Amortization – a standard financial metric for telecom systems that measures the ability to service debt and ongoing maintenance of the network
FAP	Fiber Access Point – the point at which a connection is spliced from the road (mainline network) to a premise
Fiber Count	The number of fiber strands in a given fiber cable – typically highest close to hubs and between hubs and lowest on dead end roads – a multiple of 12 (see Fiber Tube)
Fiber Strand	A single strand of fiber thinner than a human hair coated with a colored material to make it identifiable when splicing
Fiber Tube	Fiber is divided into tubes of 12 fiber strands
Fiber/Tube Colors	Each fiber strand and tube has a distinct color – strand colors are blue, orange, green, brown, slate, white, red, black, yellow, violet, rose, and aqua.
FTTH/P	Fiber to the Home or Premise – fiber goes all the way to each customer
GO Debt	General Obligation Debt – is issued by towns and supported by taxpayers – a “general obligation” of the town – VT law does not allow GO debt to be used by towns to finance telecom systems (other than for services used by the town internally)
GPON	Gigabit Passive Optical Network – requires no electronics between central hub site and premise – uses 32 way splitters – used by Verizon Fios and most FTTH providers in the US
Gross Margin	A measure of network profitability = Revenues less Cost of Goods Sold – can also be expressed as a percentage of revenue
Home Run	Network using one strand of fiber to each premise, with 32 way splitter in the hub – requires high fiber count, but allows for higher bandwidth to select locations

Hub Site	Houses transceivers to distribute and receive laser light signals for the "last mile" – typically 10-15 miles – in VT this means roughly one hub site in the center of each town
Installation	Installing the home transceiver (ONT) for the fiber network (and attaching phone where necessary)
ISP	Internet Service Provider - the entity providing Internet service
Last Mile Fiber	Fiber designed for local distribution with FAPs (a local road with access to each driveway along it)
Latency	The delay between sending a bit and receiving a response – can be very high for geo-stationary satellite connections making certain Internet capabilities (such as VPN) impossible
Light Level	the strength of a light signal at various points in the network – a certain minimum light level is needed at each customer to provide service – light levels are reduced ("attenuated") by distance, # of splices, splice quality, bending, crimping, etc.
Lit	A network is lit once light levels have been tested and electronics are activated in the hub
Long Haul Fiber	Like Middle Mile but longer – typically used for Internet backhaul (to Boston or Albany or Portland)
Mainline Build	Fiber installed on public roads (i.e., not the drop)
Make-Ready	The process and cost of making utility poles ready to accept an ISP's gear – this is done by utilities – the timing and cost of this can be a major factor in a new ISP's success (or failure)
Middle Mile fiber	Fiber typically going from town to town, with no FAPs for local distribution (similar to an Interstate highway with limited exits)
Non-recourse Debt	Debt that is NOT supported by a general obligation of the town – can be secured by assets or revenues or be unsecured
ONT/CPE	Optical Network Transceiver/Consumer Premise Equipment – typically comes with a WiFi router built in
OTMR	One Touch Make-Ready – regulations whereby one (or at most two) trucks/crews are sent out to make a pole ready (rather than each attachee – phone/cable/other ISP sending their own) – does not generally apply to make-ready by electric utilities because of the

	special training and equipment needed to operate in the electrical "space"
OTT Video	Over the top video a.k.a. streaming – it is "over the top" using a basic Internet connection and not controlled by the ISP
Passing	A residence/business/E911 location that is passed by the lit network
Peak Hour	The hour of the day where Internet usage peaks – typically 9-11 PM (streaming) but changing now due to pandemic
Penetration Rate	Customers divided by Passings, a.k.a Take Rate
Pole Attachee	Any utility having equipment on a pole – typically power and phone in underserved areas, plus cable in denser areas and sometimes other fiber providers (often middle mile, not last mile)
Revenue Bonds	Bonds that are supported by the revenues from a given asset financed by the bonds – a form of non-recourse debt
Sag	The amount a cable attached to a pole sags between poles – the lowest attachee on a pole cannot "sag" closer than 16' to the ground – otherwise pole needs to be replaced with a larger pole to allow a new attachee (which is very expensive)
Slack	Extra fiber left in loops to make maintenance easier – typically ~10%
Strand	the "other" strand - The metal carrier cable to which fiber is attached between poles
Streaming	Usually refers to watching video over an Internet connection (but can also be music/audio) – Streaming requirements vary by user hardware and streaming video providers – standard SD video (480p) requires 3Mbps, HD video (720 or 1080 p) requires 5Mbps per stream, and 4K/8K video can require 25+Mbps
Subordinated Debt	Debt that has a lower rank in terms of repayment than other ("senior") debt – typically has a higher interest rate to compensate for increased risk
Subscriber	A residence or business that has signed up for service
Symmetrical	A connection supporting the same speeds in both directions
Transport Fiber	Fiber used for communications from hub-to-DSP or hub-to-hub

Triple Play	Internet Phone and Video
Underground Drop	Drop that is underground – typically in conduit, which can be re-used if large enough – fiber can share conduit with phone or cable plant but not electricity – some homes with underground drops have only one conduit (for electricity) – the phone lines are “direct buried” without conduit – in these cases the customer must install new conduit
Universal Coverage	Covering EVERY premise in a town/region (with the possible exception of premises that are off grid or served by a pole line from a town outside the service area)
VOIP	Voice Over Internet Protocol (i.e., voice service over Internet)
VPN	Virtual Private Network – used by companies to secure their employee’s connection to company servers when working away from the office - can also be used to disguise an Internet user’s actual location by sending and receiving traffic through an intermediate server